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Eto

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(54) **DEVELOPER CONTAINER AND IMAGE FORMING APPARATUS INCLUDING THE SAME**

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G03G 15/08 (2006.01)

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CPC ***G03G 15/0865*** (2013.01); ***G03G 15/0886*** (2013.01)

(58) **Field of Classification Search**
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See application file for complete search history.

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Primary Examiner — Roy Y Yi
(74) *Attorney, Agent, or Firm* — Gerald E. Hespos; Michael J. Porco; Matthew T. Hespos

(57) **ABSTRACT**

A developer container (**30**) includes a container body (**31**), a movable wall (**34**), and a backward movement preventing mechanism (**55**). The container body (**31**) includes an inner surface (**31**K) defining a cylindrical internal space (**31**H) extending in a longitudinal direction, and a developer discharge port (**319**). The movable wall (**34**) includes an outer surface (**34**K) disposed slidably in close contact with the inner surface (**31**K) of the container body (**31**), and a conveying surface (**340**S). The conveying surface (**340**S) defines a storage space (**31**S) for developer. The movable wall (**34**) moves in the longitudinal direction from an initial position at one end side to the developer discharge port (**319**) while conveying the developer in the storage space (**31**S) to the developer discharge port (**319**). The backward movement preventing mechanism (**55**) prevents the movable wall (**34**) at the developer discharge port (**319**) from moving back toward the initial position.

5 Claims, 18 Drawing Sheets

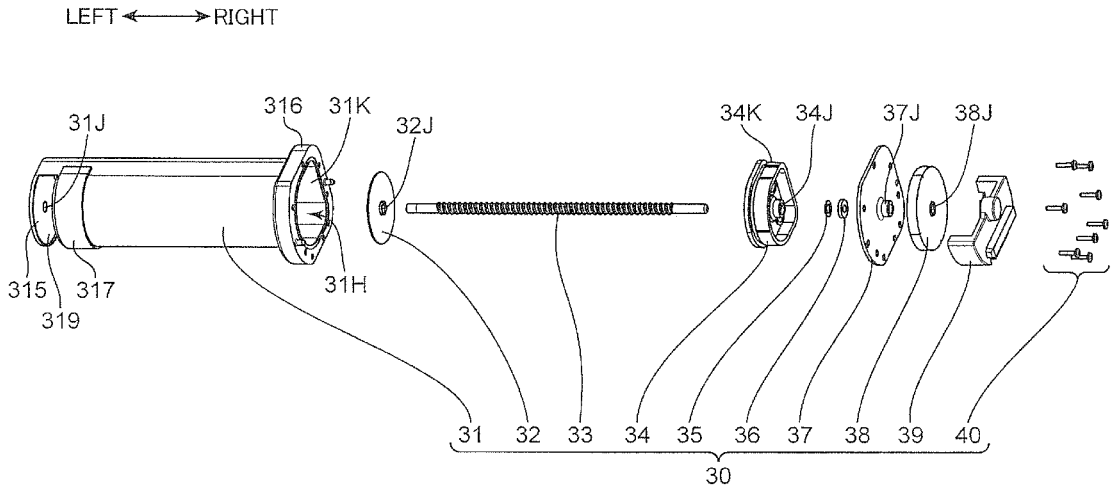

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FIG.1

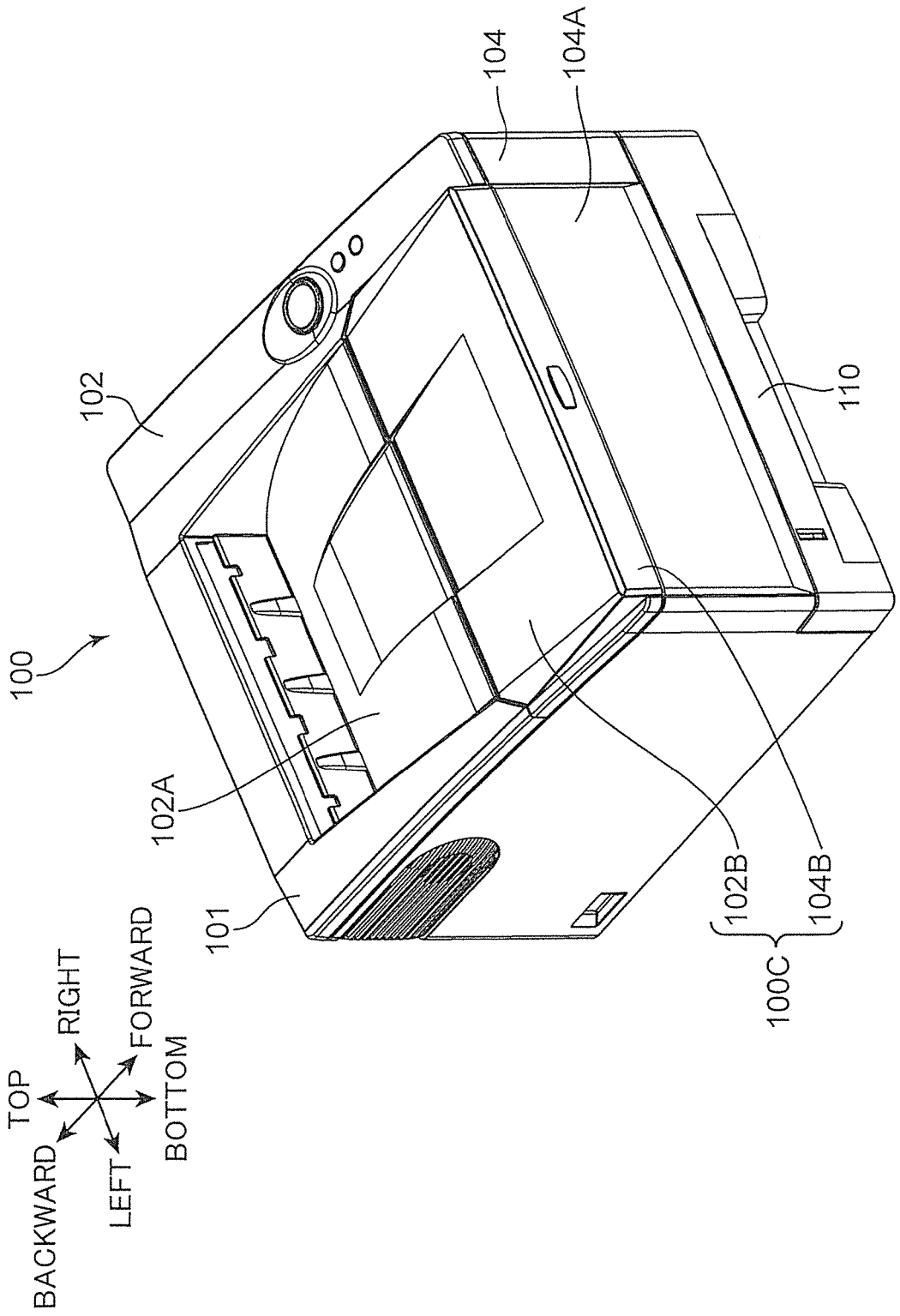

100
102
104
104A
110
102A
101
102B
104B
100C
TOP
BOTTOM
RIGHT
LEFT
FORWARD
BACKWARD

FIG.2

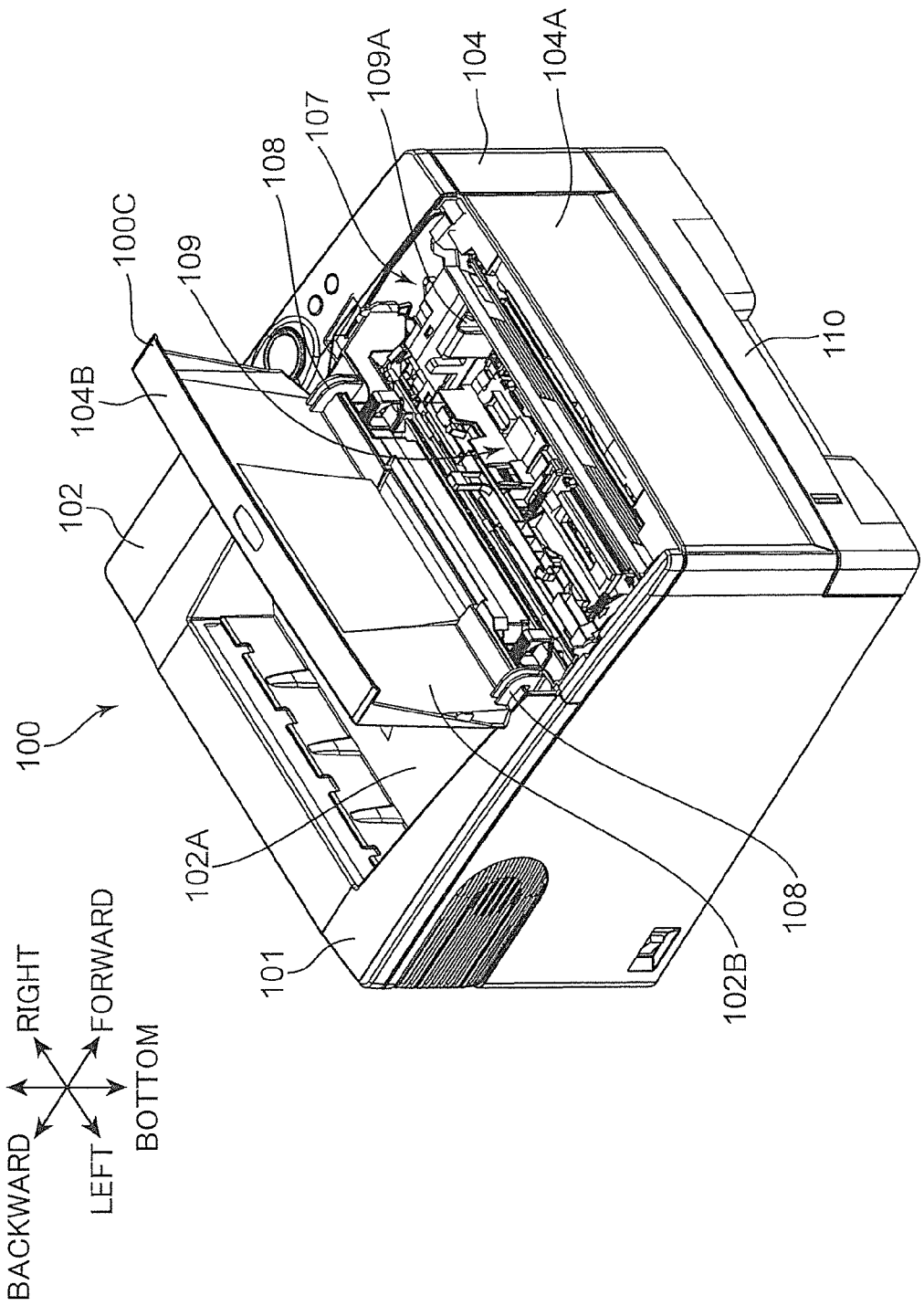
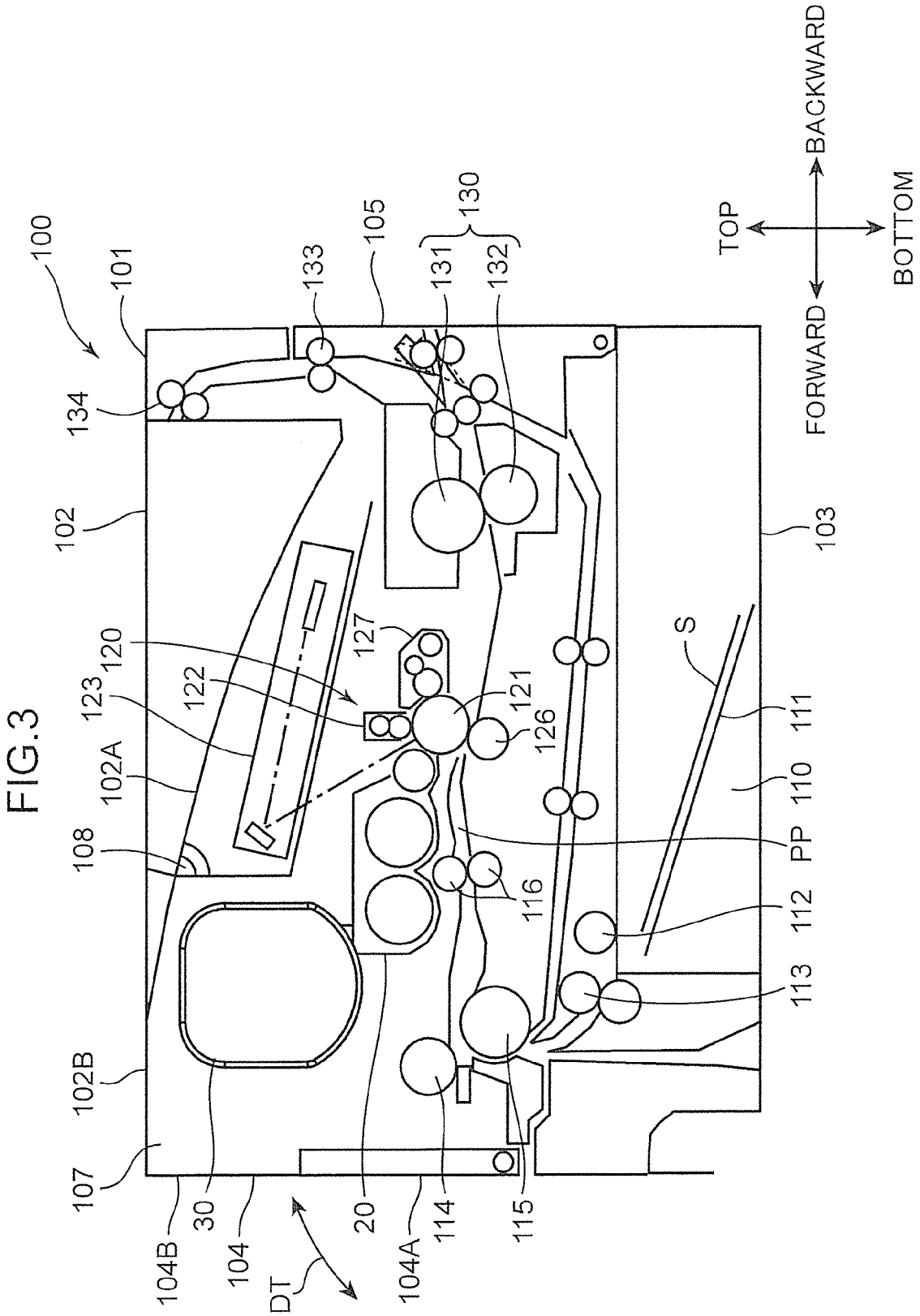

100
101
102
102A
102B
104
104A
104B
107
108
109
109A
100C
110
TOP
BOTTOM
RIGHT
LEFT
FORWARD
BACKWARD

FIG.3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101
102
102A
102B
103
104
104A
104B
105
107
108
110
111
112
113
114
115
116
120
121
122
123
126
127
130
131
132
133
134
20
30
DT
PP
S
TOP
BOTTOM
FORWARD
BACKWARD

FIG.4

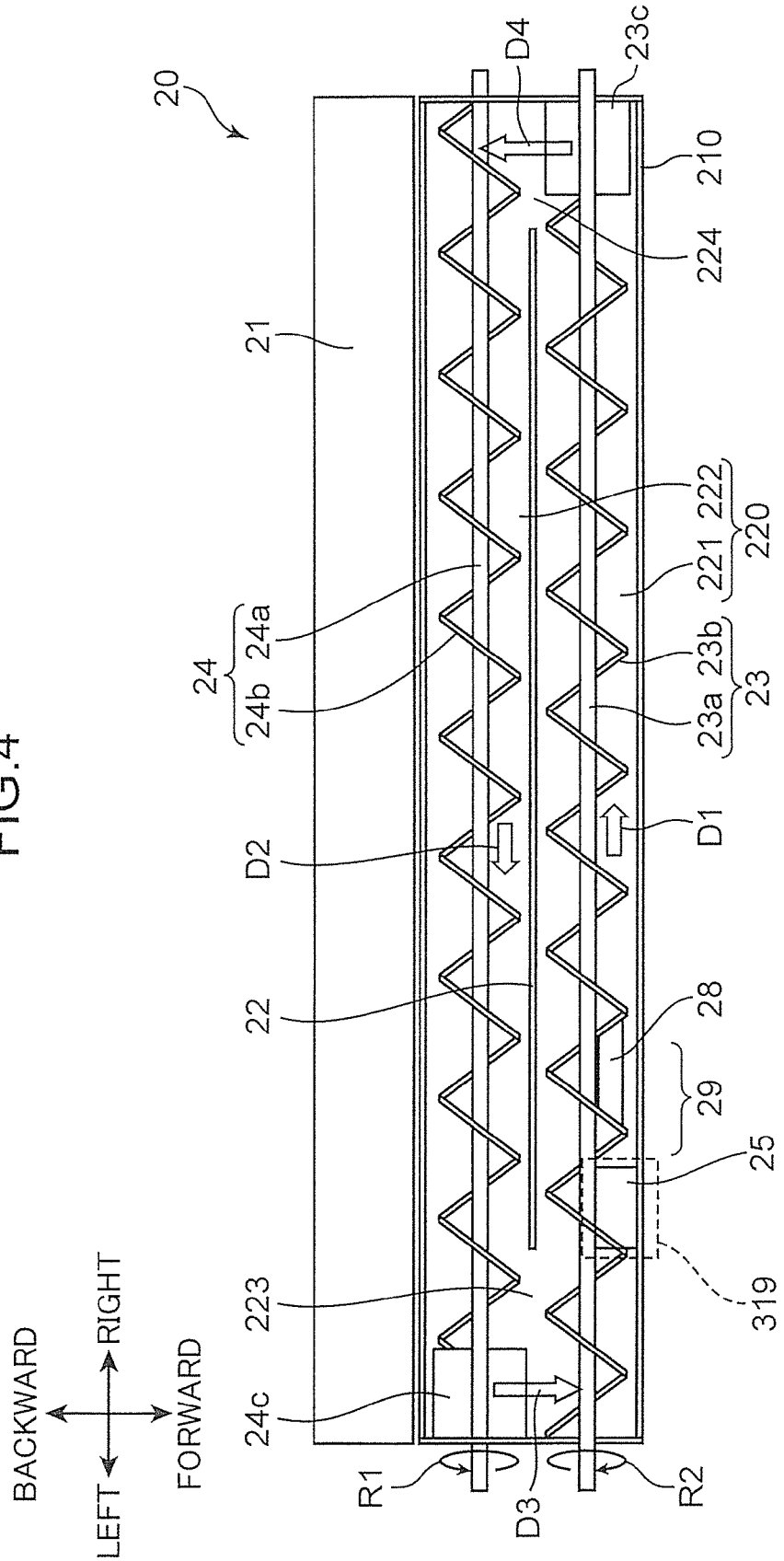

20
21
22
223
24
24a
24b
24c
D1
D2
D3
D4
R1
R2
210
220
221
222
23
23a
23b
23c
224
25
28
29
319
BACKWARD
FORWARD
LEFT
RIGHT

FIG.5

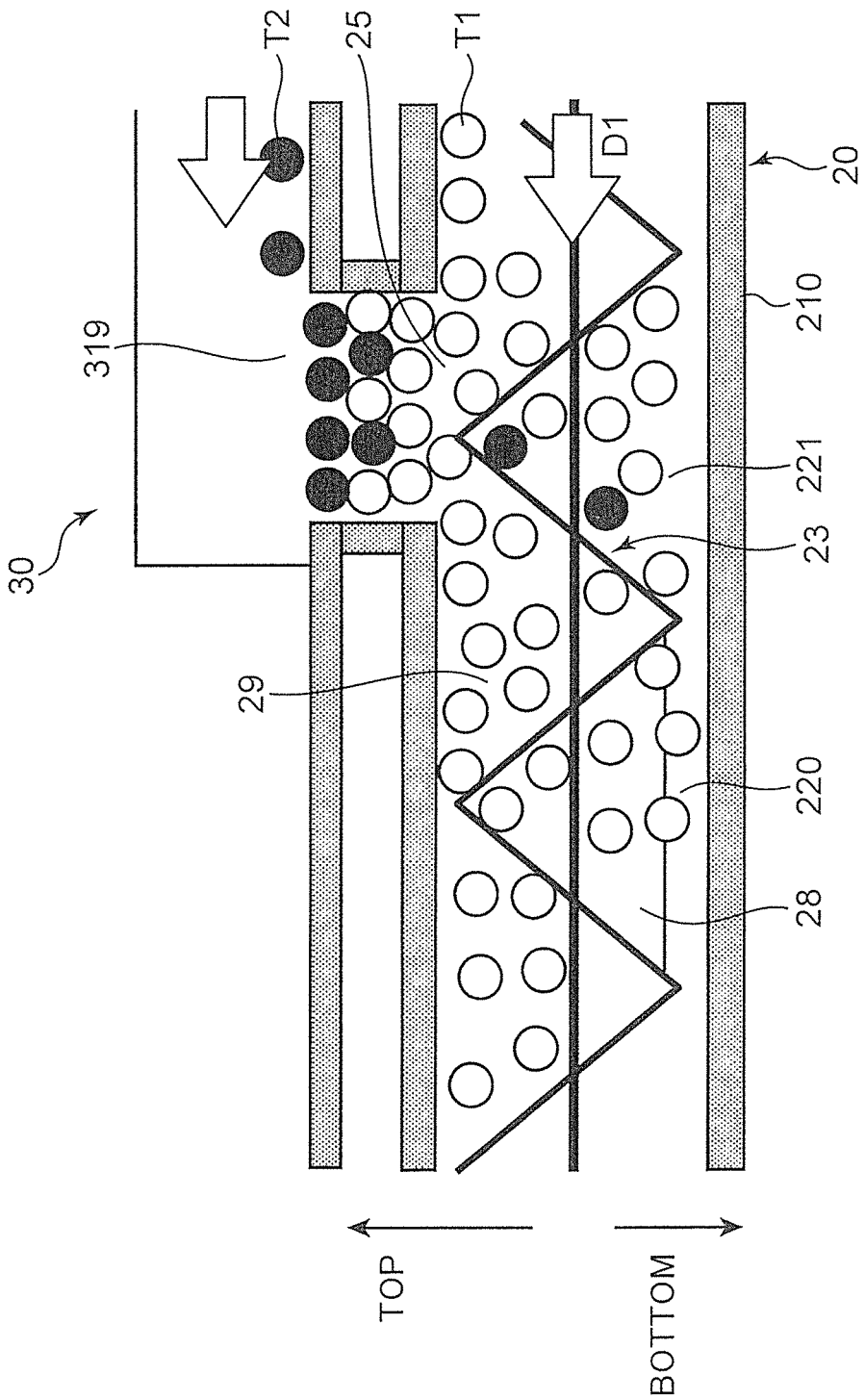


FIG.6

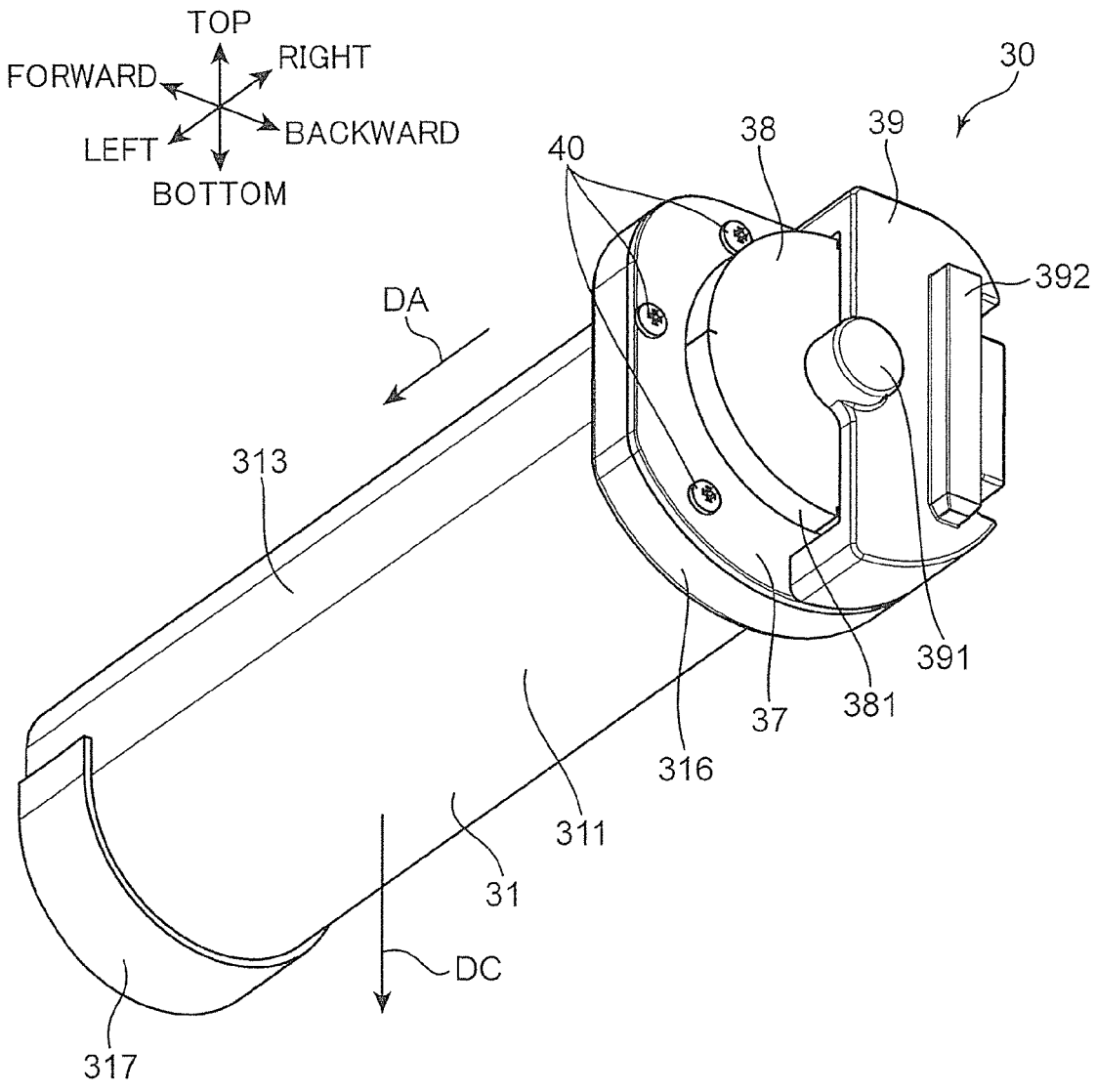
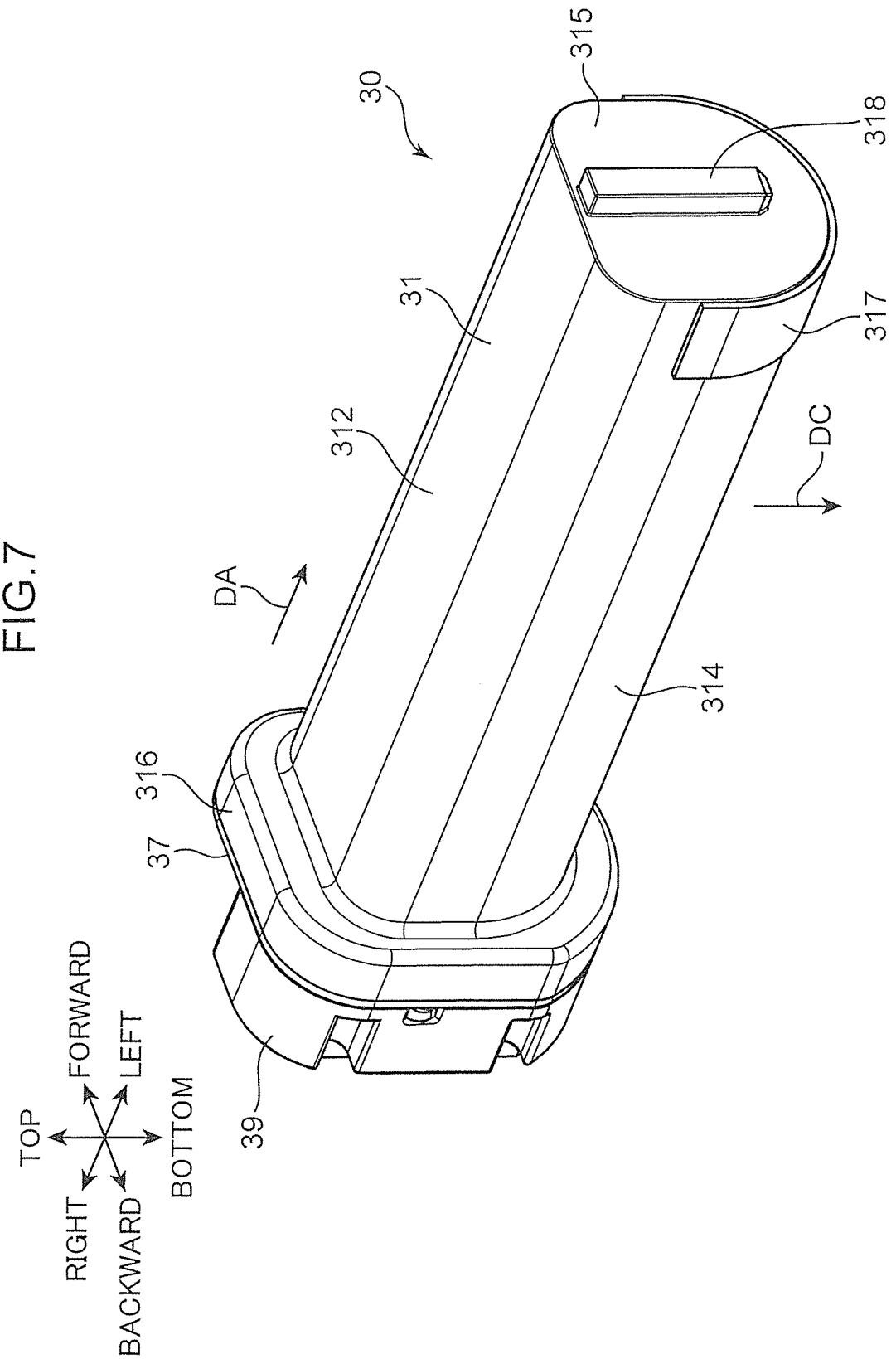

TOP
FORWARD
RIGHT
LEFT
BACKWARD
BOTTOM
30
40
38
39
392
DA
313
391
381
37
316
311
31
DC
317

FIG.7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315
318
31
317
312
DC
DA
314
316
37
39
TOP
FORWARD
LEFT
BOTTOM
RIGHT
BACKWARD

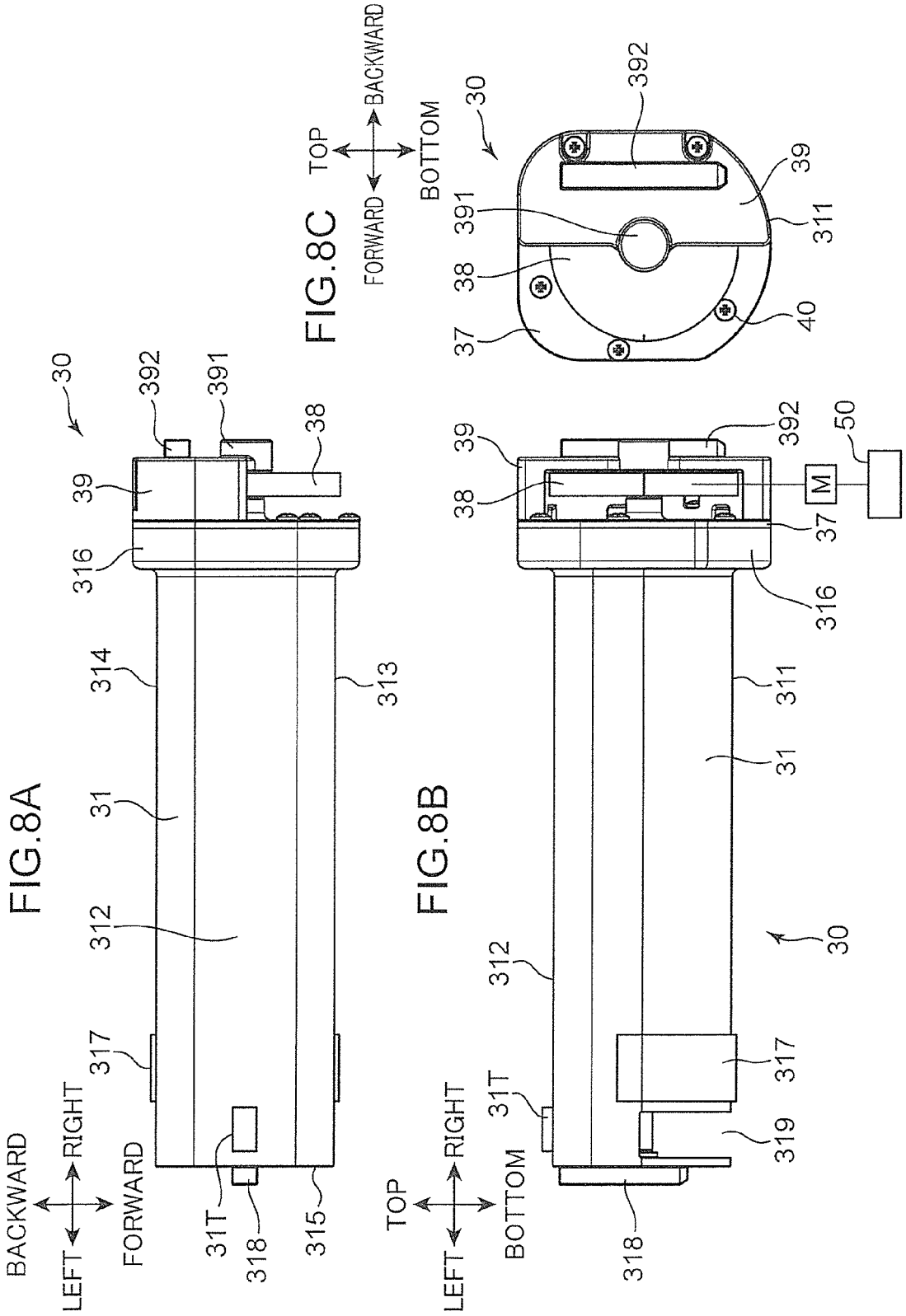


FIG.8A
FIG.8B
FIG.8C
30
31
312
313
314
315
316
317
318
319
31T
38
39
391
392
311
37
40
50
M
BACKWARD
FORWARD
LEFT
RIGHT
TOP
BOTTOM

FIG.9

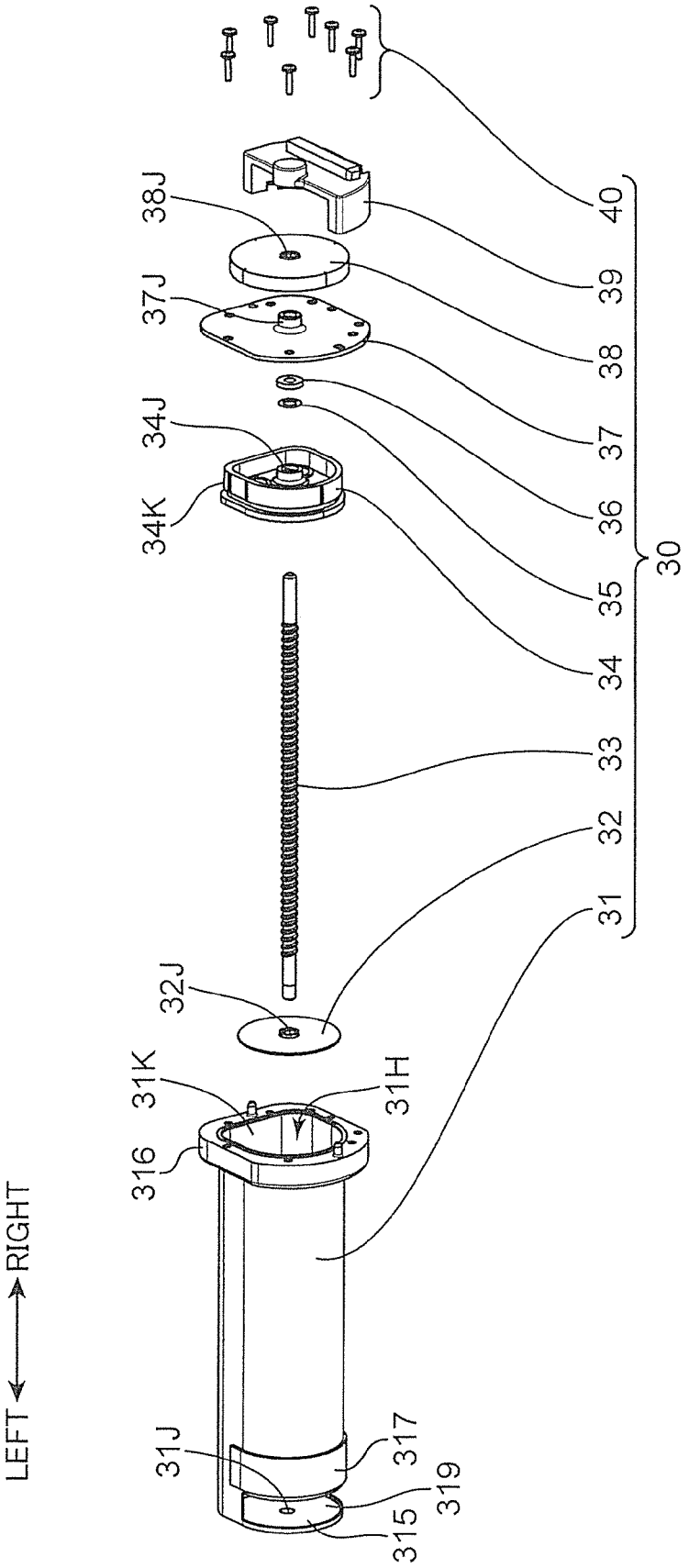

40
38J
39
37J
38
34J
37
34K
36
35
34
30
33
32
31
32J
31K
31H
316
LEFT
RIGHT
31J
317
319
315

FIG.10A

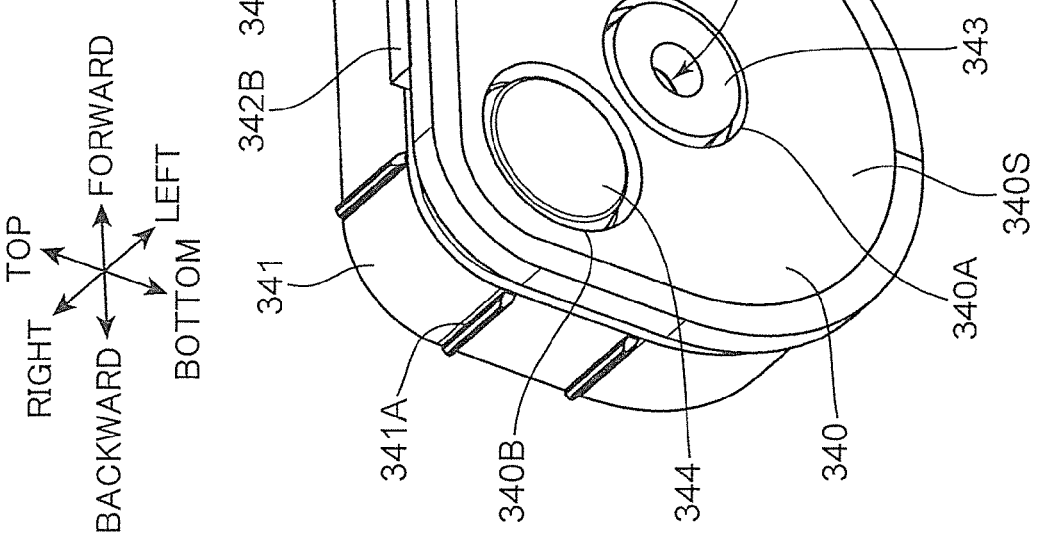


FIG.10B

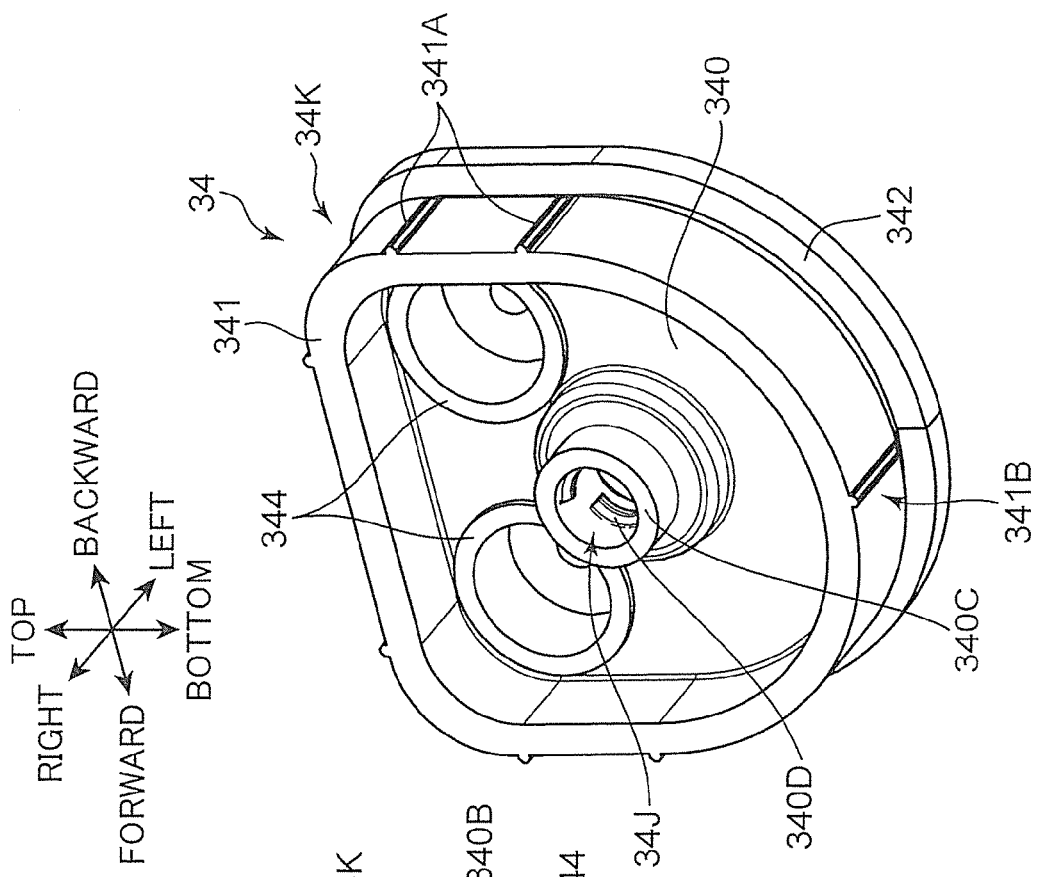


FIG. 11

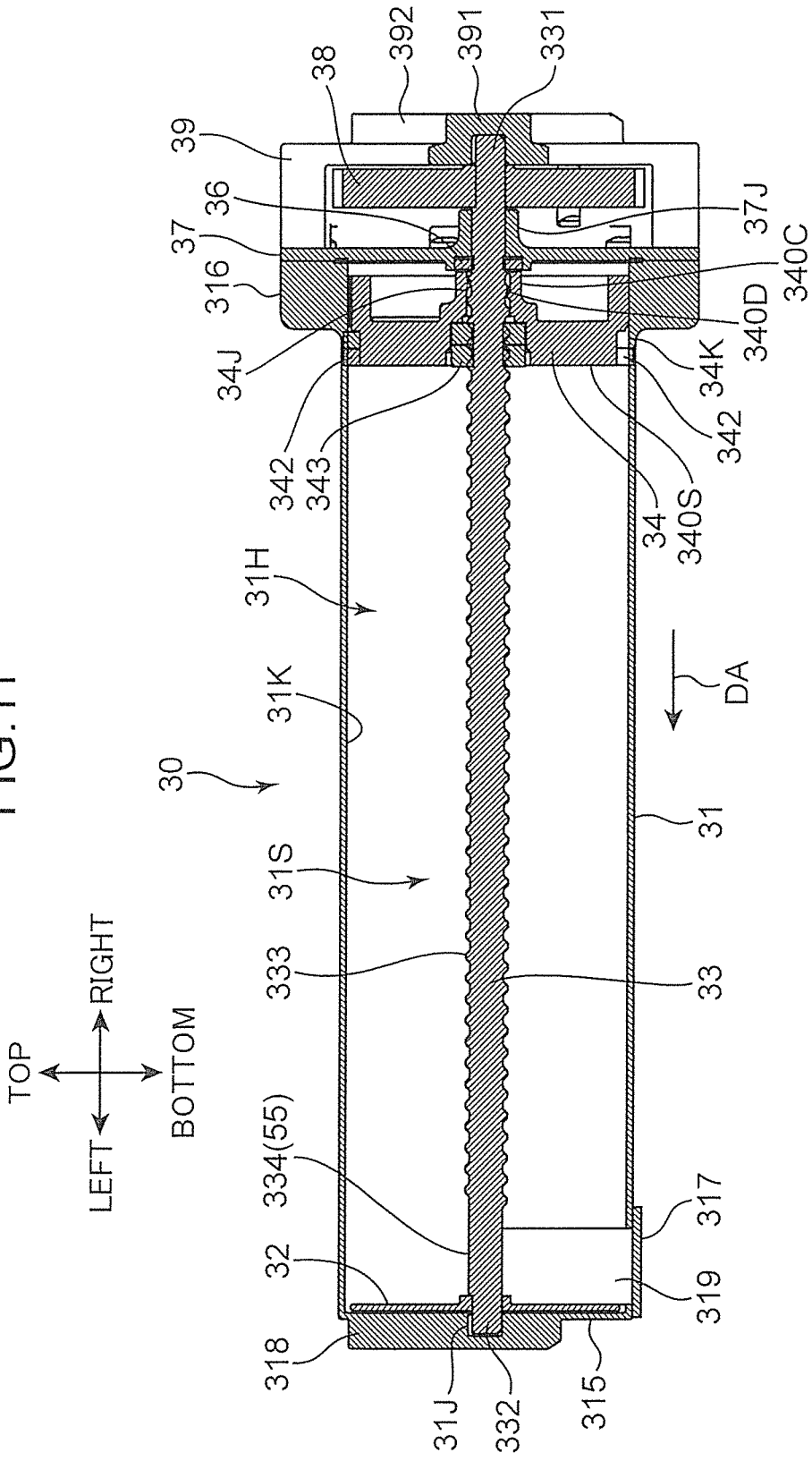

392
391
331
38
39
36
37J
37
316
340C
340D
34J
34K
342
343
34
340S
31H
31K
DA
30
31
31S
333
33
TOP
RIGHT
LEFT
BOTTOM
334(55)
317
32
319
318
31J
332
315

FIG.12A

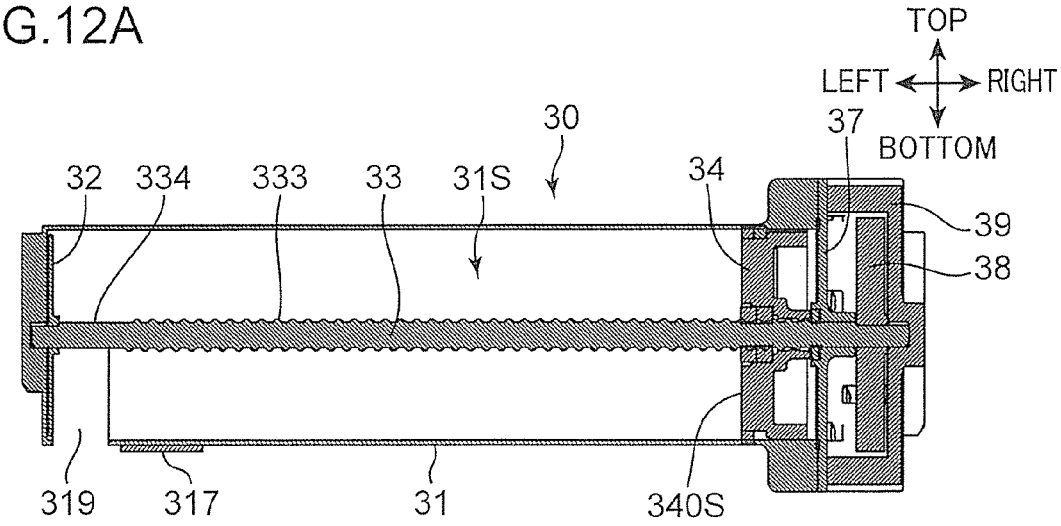


FIG.12B

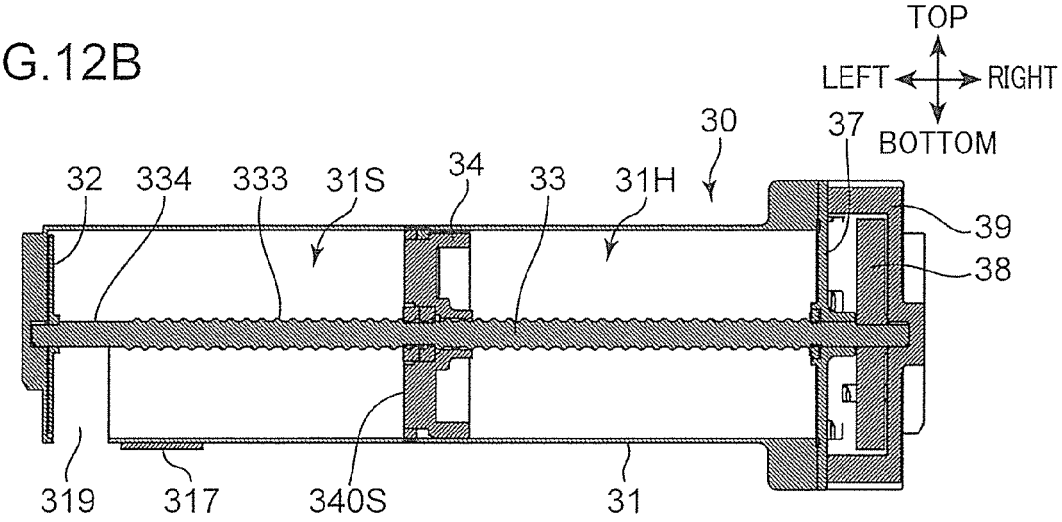


FIG.12C

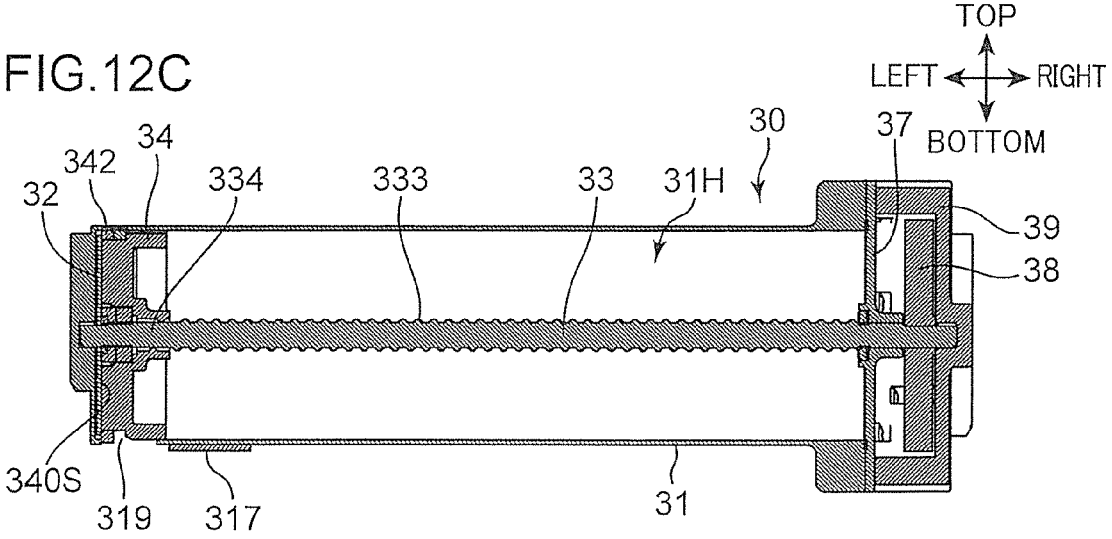


FIG.13A

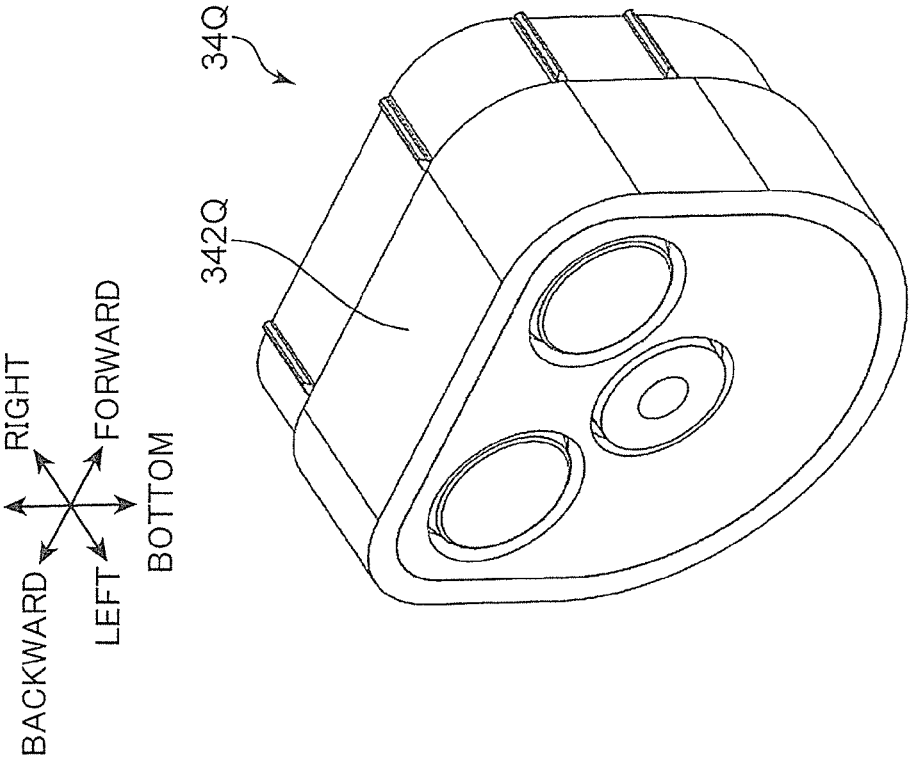


FIG.13B

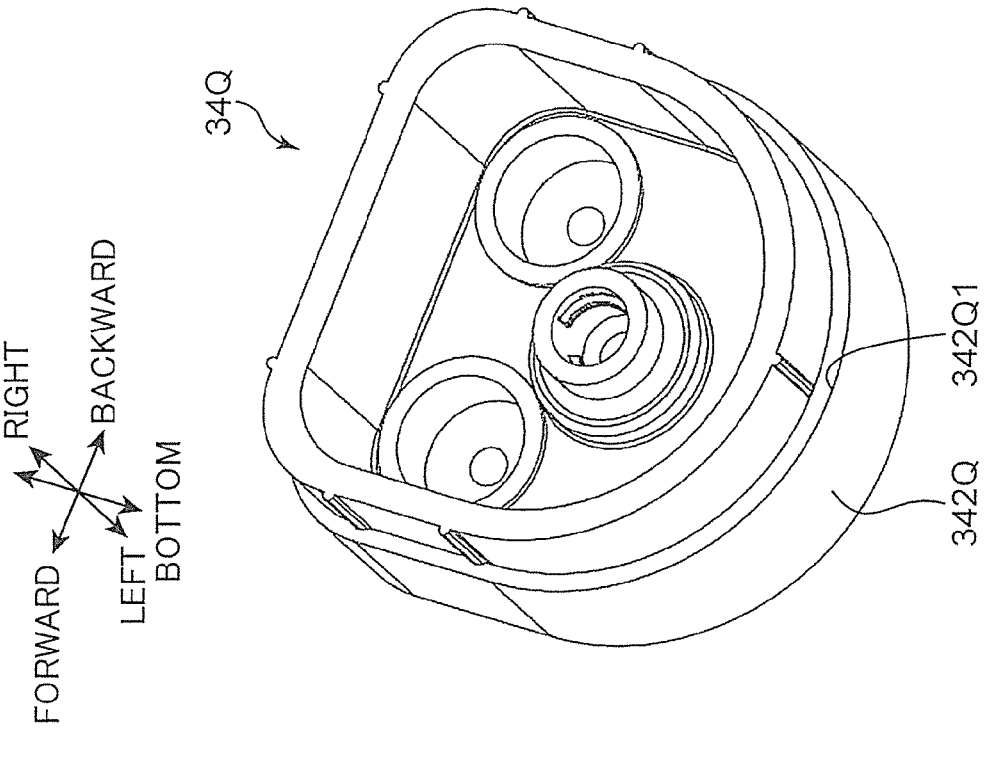


FIG.14

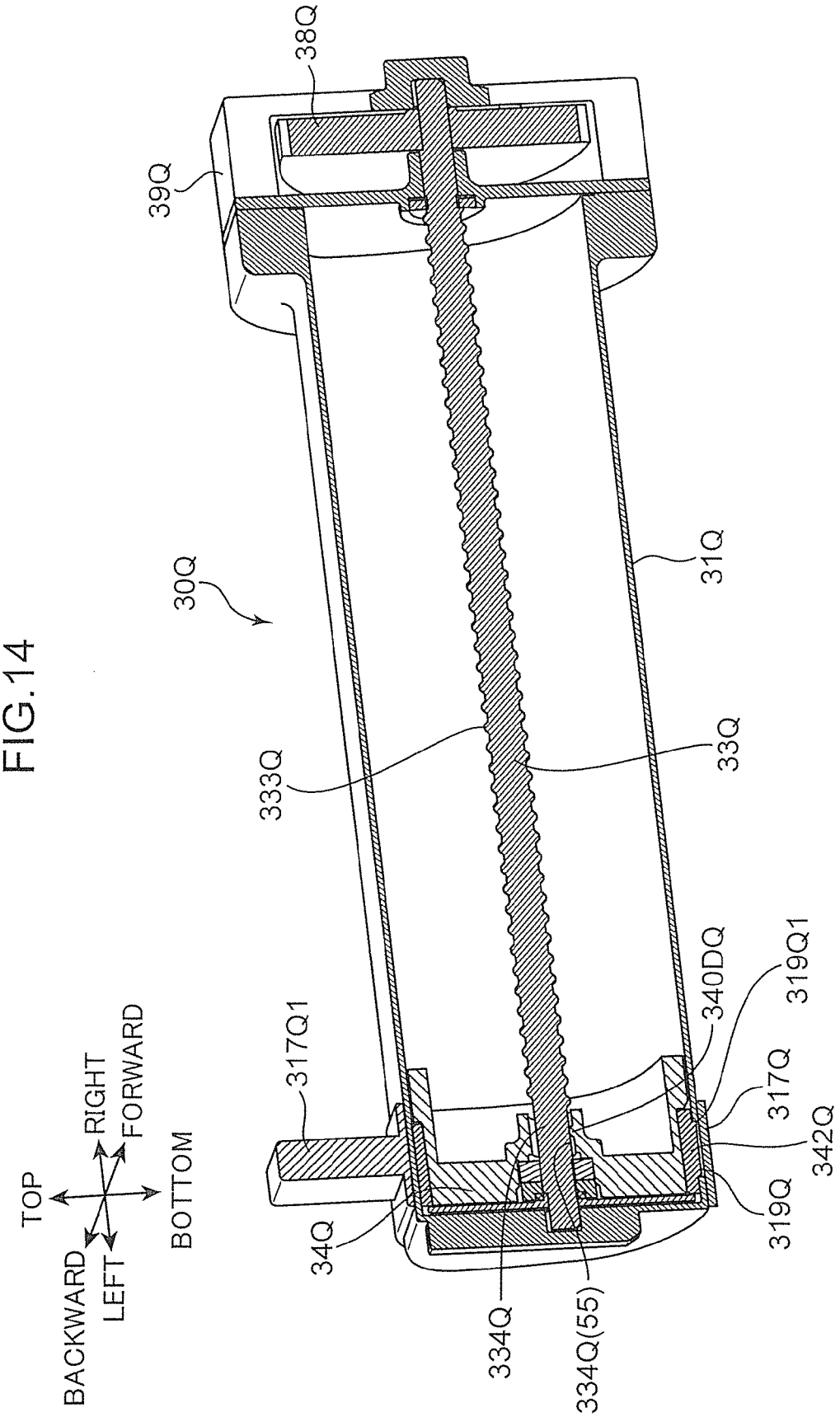

38Q
39Q
30Q
31Q
333Q
33Q
317Q1
340DQ
319Q1
317Q
342Q
319Q
34Q
334Q
334Q(55)
TOP
RIGHT
FORWARD
BOTTOM
BACKWARD
LEFT

FIG.15

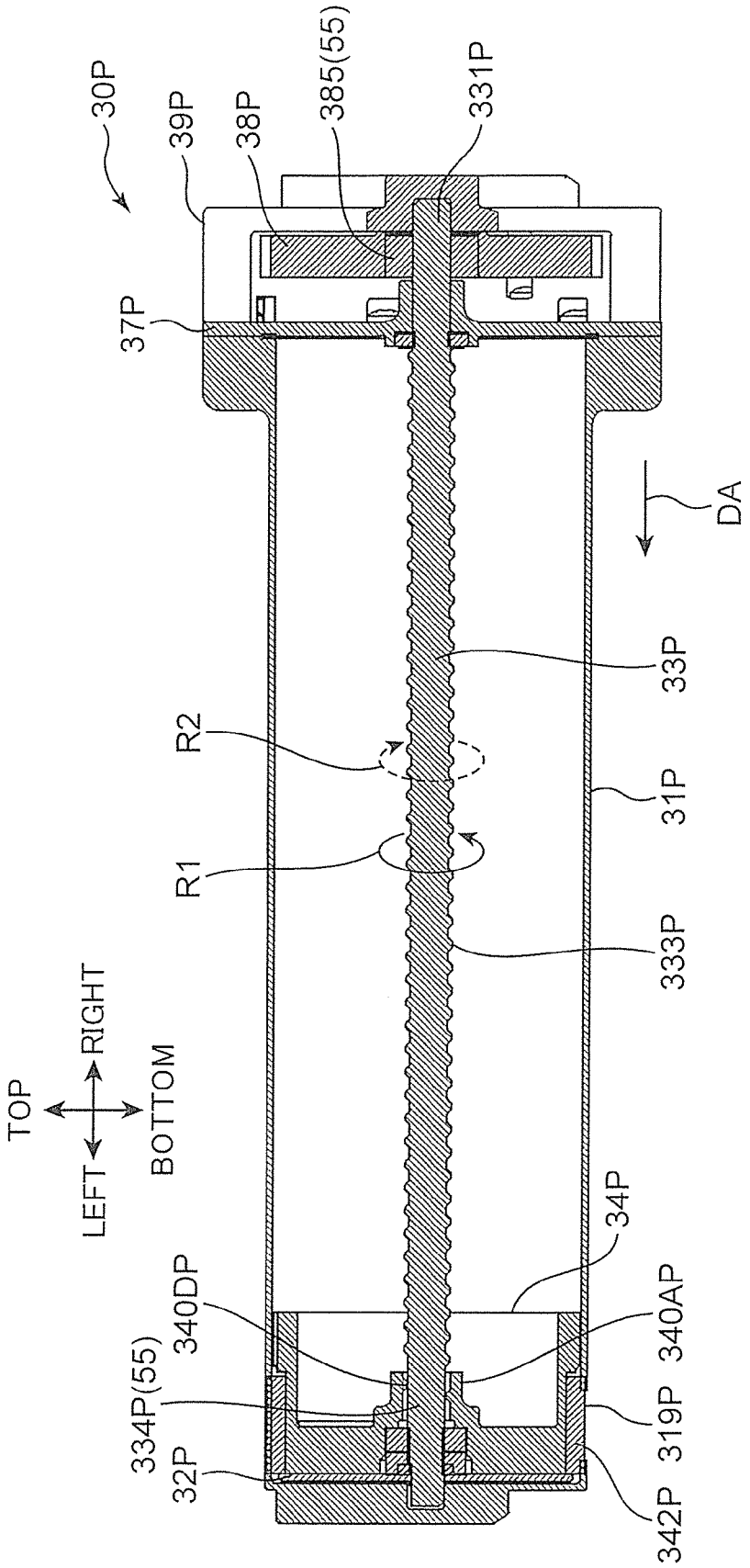

30P
39P
38P
385(55)
331P
37P
DA
33P
R2
31P
R1
333P
TOP
RIGHT
LEFT
BOTTOM
34P
340DP
340AP
334P(55)
319P
32P
342P

FIG. 16

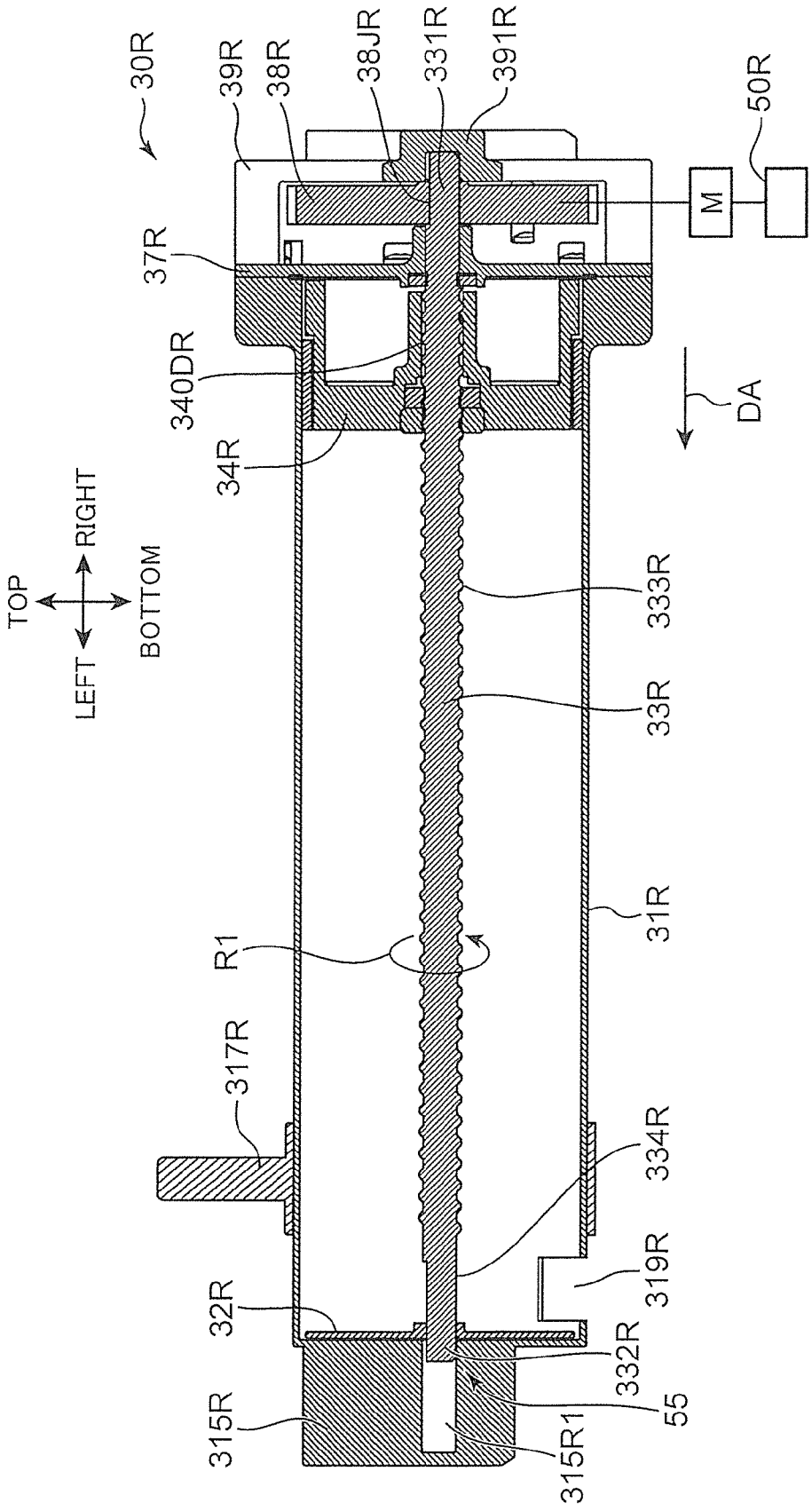

30R
39R
38R
38JR
331R
391R
50R
M
37R
340DR
34R
DA
TOP
RIGHT
LEFT
BOTTOM
333R
33R
31R
R1
317R
334R
319R
32R
332R
55
315R
315R1

FIG.17

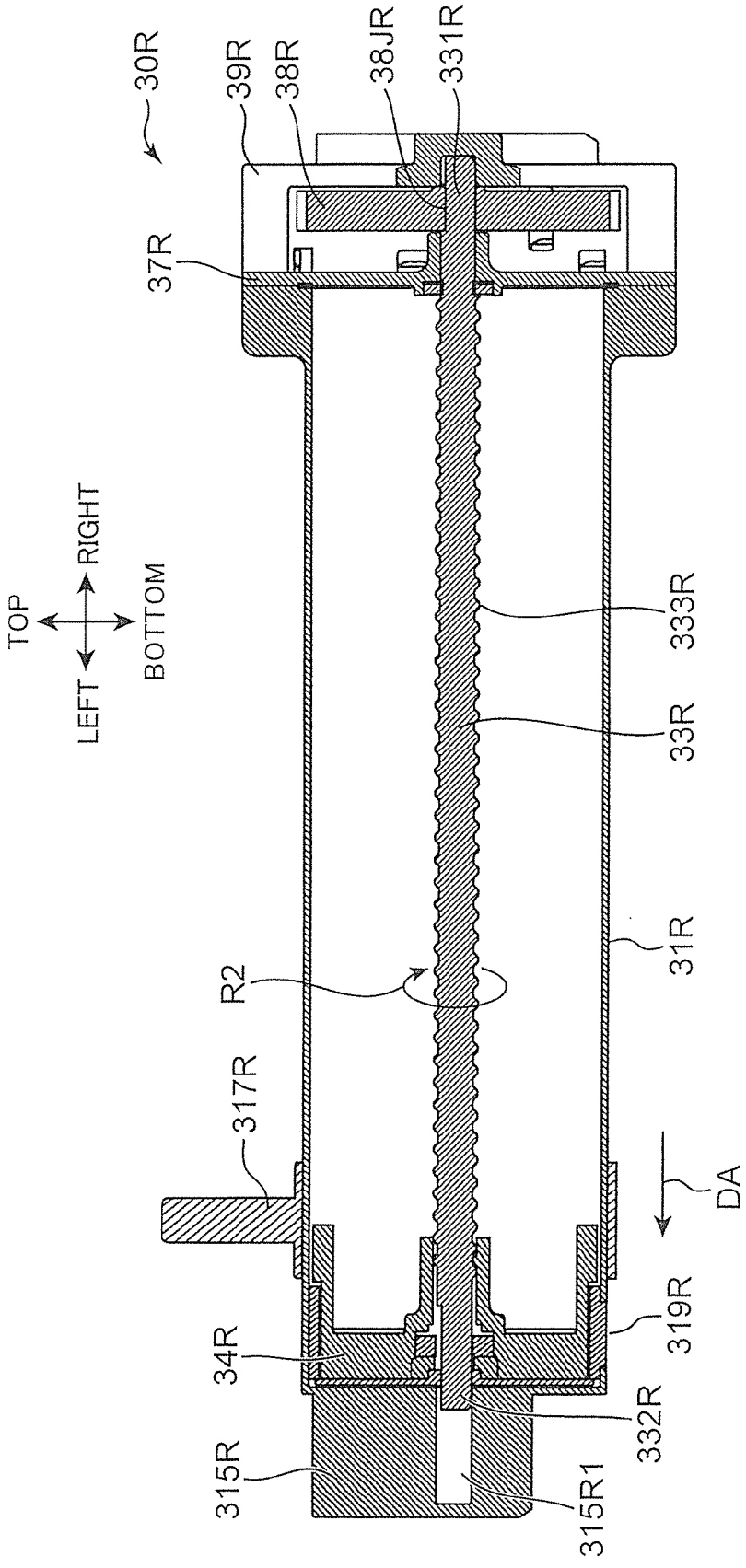
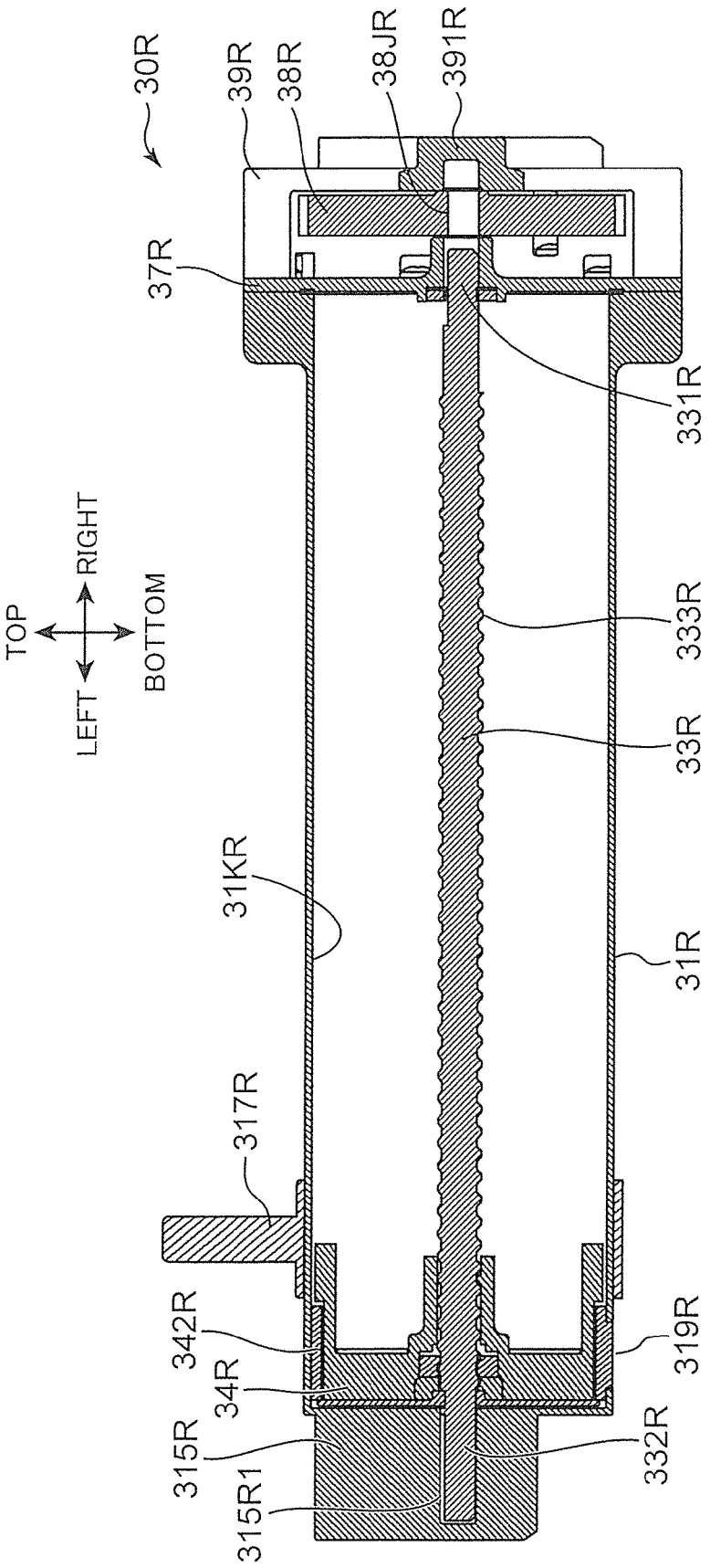

30R
39R
38R
38JR
331R
37R
TOP
RIGHT
LEFT
BOTTOM
333R
33R
31R
R2
317R
DA
319R
34R
332R
315R
315R1

FIG.18


30R
39R
38R
38JR
391R
37R
331R
333R
33R
31KR
31R
317R
342R
34R
315R
315R1
319R
332R
TOP
RIGHT
LEFT
BOTTOM

DEVELOPER CONTAINER AND IMAGE FORMING APPARATUS INCLUDING THE SAME

TECHNICAL FIELD

The present invention relates to a developer container for containing developer and an image forming apparatus including the developer container.

BACKGROUND ART

Conventionally, toner containers such as one disclosed in Japanese Unexamined Patent Publication No. 2003-280344 are known as developer containers for containing developer. The toner container includes a toner discharge port and a rotary stirring member. Toner is discharged through the toner discharge port by rotation of the stirring member.

Japanese Unexamined Patent Publication No. 2009-265395 discloses a waste toner container for containing developer. The waste toner container includes a cylindrical container body having an outer circumferential portion formed with a helical groove. Collected toner is conveyed to one end of the container body along the helical groove by rotation of the container body.

In the toner container disclosed in Japanese Unexamined Patent Publication No. 2009-265395, toner is liable to remain in the region not affected by the rotational force of the conveying member, which makes it difficult to use up all the toner in the container. Further, even if the technique used for the waste container disclosed in Japanese Unexamined Patent Publication No. 2009-265395 is applied to the toner container, toner adhered to the groove will continue to rotate with the container body, so that the toner will remain in the container body. This has been a problem.

The present invention aims to provide a developer container capable of reducing the amount of developer remaining in a container body and reliably sealing a developer discharge port at the end of use of the developer container, and an image forming apparatus including the developer container.

SUMMARY

A developer container according to an aspect of the present invention comprises: a container body including an inner surface defining a cylindrical internal space extending in a longitudinal direction, and a storage space provided in the internal space for containing developer, the container body being formed with a developer discharge port in a lower part of the inner surface and communicating with the storage space for discharging developer therethrough; a movable wall disposed in the internal space of the container body, and including an outer surface disposed slidably in close contact with the inner surface, and a conveying surface defining the storage space in cooperation with the inner surface of the container body, the movable wall being movable in the longitudinal direction from an initial position set at one end side to the developer discharge port lying at the other end side of the internal space to seal the developer discharge port by the outer surface, while conveying the developer in the storage space to the developer discharge port; and a backward movement preventing mechanism configured to prevent the movable wall at the developer discharge port from moving back toward the initial position.

An image forming apparatus according to another aspect of the present invention comprises: the above-described developer container; an image carrier having a surface for allowing an electrostatic latent image to be formed thereon and operable to carry a developed image; a developing device configured to receive the developer supplied from the developer container and to supply the developer to the image carrier; and a transfer section configured to transfer the developed image from the image carrier onto a sheet.

The present invention provides a developer container capable of reducing the amount of developer remaining in a container body and reliably sealing a developer discharge port at the end of use of the developer container, and an image forming apparatus including the developer container.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a perspective view of an image forming apparatus according to an embodiment of the present invention.

FIG. **2** is a perspective view of the image forming apparatus according to the embodiment of the present invention, a part of the apparatus being opened.

FIG. **3** is a schematic sectional view showing an internal structure of the image forming apparatus according to the embodiment of the present invention.

FIG. **4** is a schematic plan view showing an internal structure of a developing device according to the embodiment of the present invention.

FIG. **5** is a schematic sectional view illustrating supply of developer to the developing device according to the embodiment of the present invention.

FIG. **6** is a perspective view of a developer container according to a first embodiment of the present invention.

FIG. **7** is a perspective view of the developer container according to the first embodiment of the present invention.

FIG. **8**A is a plan view of the developer container according to the first embodiment of the present invention.

FIG. **8**B is a front view of the developer container according to the first embodiment of the present invention.

FIG. **8**C is a side view of the developer container according to the first embodiment of the present invention.

FIG. **9** is an exploded perspective view of the developer container according to the first embodiment of the present invention.

FIG. **10**A is a perspective view of a movable wall of the developer container according to the first embodiment of the present invention.

FIG. **10**B is a perspective view of the movable wall of the developer container according to the first embodiment of the present invention.

FIG. **11** is a sectional view of the developer container according to the first embodiment of the present invention.

FIG. **12**A is a sectional view illustrating a movement state of the movable wall in the developer container according to the first embodiment of the present invention.

FIG. **12**B is a sectional view illustrating a movement state of the movable wall in the developer container according to the first embodiment of the present invention.

FIG. **12**C is a sectional view illustrating a movement state of the movable wall in the developer container according to the first embodiment of the present invention.

FIG. **13**A is a perspective view of a movable wall of a developer container according to a second embodiment of the present invention.

FIG. **13**B is a perspective view of the movable wall of the developer container according to the second embodiment of the present invention.

FIG. **14** is a sectional perspective view of the developer container according to the second embodiment of the present invention.

FIG. **15** is a sectional view of a developer container according to a third embodiment of the present invention.

FIG. **16** is a sectional view of a developer container according to a fourth embodiment of the present invention.

FIG. **17** is a sectional view of the developer container according to the fourth embodiment of the present invention.

FIG. **18** is a sectional view of the developer container according to the fourth embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

Hereinafter, an embodiment of the present invention will be described with reference to the accompanying drawings. FIGS. **1** and **2** are perspective views of a printer **100** (image forming apparatus) according to an embodiment of the present invention. FIG. **3** is a schematic sectional view showing an internal structure of the printer **100** shown in FIGS. **1** and **2**. The printer **100** shown in FIGS. **1** to **3**, which exemplifies the image forming apparatus, is configured as a so-called monochrome printer. However, other apparatuses may alternatively be provided as an image forming apparatus in other embodiments, such as a color printer, a facsimile apparatus or a multifunctional apparatus equipped with these functions, or another type of apparatus for forming a toner image on a sheet. It should be noted that hereinafter, terms indicating directions such as "top" "bottom" "forward" "backward" "left" and "right" are intended merely for descriptive purposes, and not for limiting the principle of the image forming apparatus.

The printer **100** includes a housing **101** for housing various components that are used for forming an image on a sheet S. The housing **101** includes a top wall **102** defining the top surface of the housing **101**, a bottom wall **103** (FIG. **3**) defining the bottom surface of the housing **101**, a main body rear wall **105** (FIG. **3**) connecting the top wall **102** and the bottom wall **103**, and a main body front wall **104** located in front of the main body rear wall **105**. The housing **101** includes a main body internal space **107** where various components are placed. A sheet conveyance passage PP extends in the main body internal space **107** of the housing **101**, the sheet conveyance passage PP for allowing passage of a sheet S in a given conveying direction. Further, the printer **100** includes an opening/closing cover **100**C mounted on the housing **101** in an openable and closable manner.

The opening/closing cover **100**C includes a front wall upper portion **104**B constituting an upper portion of the main body front wall **104**, and a top wall front portion **102**B constituting a front portion of the top wall **102**. The opening/closing cover **100**C can be vertically opened and closed with unillustrated hinge shafts acting as a fulcrum, the hinge shafts being respectively disposed on a pair of arms **108** disposed at lateral opposite ends of the opening/closing cover **100**C (FIG. **2**). When the opening/closing cover **100**C is open, the main body internal space **107** is exposed to the outside at the top thereof. On the other hand, when the opening/closing cover **100**C is closed, the main body internal space **107** is closed at the top thereof.

A sheet discharge section **102**A is disposed in a central part of the top wall **102**. The sheet discharge section **102**A includes an oblique surface sloping downward from a front end to a rear end of the top wall **102**. A sheet S that has been subjected to image formation in an image forming section **120** described later is discharged onto the sheet discharge section **102**A. Further, a manual feed tray **104**A is disposed in a vertically central part of the main body front wall **104**. The manual feed tray **104**A is vertically pivotable with a lower end thereof acting as a fulcrum (in the direction of an arrow DT shown in FIG. **3**).

With reference to FIG. **3**, the printer **100** includes a cassette **110**, a pickup roller **112**, a first sheet feeding roller **113**, a second sheet feeding roller **114**, a conveying roller **115**, a pair of registration rollers **116**, the image forming section **120**, and a fixing device **130**.

The cassette **110** stores sheets S therein. The cassette **110** includes a lift plate **111**. The lift plate **111** is tilted to lift the leading edges of the sheets S. The cassette **110** can be pulled out forwardly with respect to the housing **101**.

The pickup roller **112** is disposed above the leading edges of sheets S lifted by the lift plate **111**. The pickup roller **112** rotates to draw a sheet S from the cassette **110**.

The first sheet feeding roller **113** is disposed downstream of the pickup roller **112** and conveys a sheet S further downstream. The second sheet feeding roller **114** is disposed at the inner side (rear side) of the fulcrum of the manual feed tray **104**A and draws a sheet placed on the manual feed tray **104**A into the housing **101**.

The conveying roller **115** is disposed downstream of the first sheet feeding roller **113** and the second sheet feeding roller **114** in their sheet conveying direction (hereinafter, the sheet conveying direction also being simply referred to as "conveying direction", and the downstream in the sheet conveying direction also being simply referred to as "downstream"). The conveying roller **115** conveys a sheet S fed by the first sheet feeding roller **113** or the second sheet feeding roller **114** further downstream.

The pair of registration rollers **116** functions to correct the angle of a sheet S that has been obliquely conveyed. This makes it possible to adjust the position of an image to be formed on the sheet S. The pair of registration rollers **116** supplies the sheet S to the image forming section **120** in accordance with timing of image formation to be performed by the image forming section **120**.

The image forming section **120** includes a photoconductive drum **121** (image carrier), a charger **122**, an exposure device **123**, a developing device **20**, a toner container **30** (developer container), a transferring roller **126** (transfer section), and a cleaning device **127**.

The photoconductive drum **121** is in the form of a cylinder. The photoconductive drum **121** has a surface to be formed with an electrostatic latent image, and carries a toner image (developed image) corresponding to the electrostatic latent image on the surface. The charger **122** is applied with a predetermined voltage, and charges the circumferential surface of the photoconductive drum **121** substantially uniformly.

The exposure device **123** irradiates the circumferential surface of the photoconductive drum **121** charged by the charger **122** with beams of laser light. The beams of laser light are emitted in accordance with image data output from an external device (not shown) such as a personal computer which is communicably connected to the printer **100**. Consequently, the circumferential surface of the photoconductive drum **121** is formed with an electrostatic latent image corresponding to the image data.

The developing device **20** supplies toner to the circumferential surface of the photoconductive drum **121**, the circumferential surface being formed with an electrostatic latent image. The toner container **30** supplies toner to the developing device **20**. The toner container **30** is detachably attached to the developing device **20**. The developing device **20** supplies the toner to the photoconductive drum **121** to develop (visualize) the electrostatic latent image formed on the cir-

cumferential surface of the photoconductive drum **121**. Consequently, the circumferential surface of the photoconductive drum **121** is formed with a toner image (developed image).

The transferring roller **126** is disposed below and opposite the photoconductive drum **121** across the sheet conveyance passage PP. The transferring roller **126** defines a transfer nip N in cooperation with the photoconductive drum **121** for transferring a toner image onto a sheet S.

The cleaning device **127** removes, after a toner image is transferred onto a sheet S from the circumferential surface of the photoconductive drum **121**, toner remaining on the circumferential surface.

The fixing device **130** is disposed downstream of the image forming section **120** in the conveying direction, and fixes a toner image on a sheet S. The fixing device **130** includes a heating roller **131** for melting toner on the sheet S, and a pressure roller **132** for bringing the sheet S into close contact with the heating roller **131**.

The printer **100** further includes a pair of conveying rollers **133** disposed downstream of the fixing device **130**, and a pair of discharge rollers **134** disposed downstream of the pair of conveying rollers **133**. A sheet S is conveyed upward by the pair of conveying rollers **133** to be finally discharged from the housing **101** by the pair of discharge rollers **134**. The sheet S discharged from the housing **101** is placed on the sheet discharge section **102**A, thereby resulting in a stack of sheets.

<Developing Device>

FIG. **4** is a plan view showing an internal structure of the developing device **20**. The developing device **20** includes a development housing **210** in the form of a box having a longer dimension in a specific direction (an axial direction of a developing roller **21** or a left-right direction). The development housing **210** includes a storage space **220**. In the storage space **220**, there are disposed the developing roller **21**, a first stirring screw **23**, a second stirring screw **24**, and a toner supply port **25**. The present embodiment employs a one-component developing method and, therefore, the storage space **220** is filled with toner that is to be used as developer. On the other hand, in the case of a two-component developing method, a mixture of toner and carrier including a magnetic material is filled as developer. The toner is circulatively conveyed in the storage space **220** and successively supplied from the developing roller **21** to the photoconductive drum **121** in order to develop an electrostatic latent image.

The developing roller **21** is in the form of a cylinder extending in a longitudinal direction of the development housing **210**, and includes a sleeve constituting a circumferential portion of the developing roller **21** which is operable to be rotationally driven.

The storage space **220** of the development housing **210** is covered by an unillustrated top portion and divided, by a partition plate **22** extending in the left-right direction, into a first conveyance passage **221** and a second conveyance passage **222** having a longer dimension in the left-right direction. The partition plate **22** is shorter than the lateral width of the development housing **210** to define a first communication passage **223** and a second communication passage **224** respectively at the left and right sides of the partition plate **22**, the first and second communication passages **223** and **224** allowing communication between the first conveyance passage **221** and the second conveyance passage **222**. Consequently, there is a circulation passage constituted by the first conveyance passage **221**, the second communication passage **224**, the second conveyance passage **222**, and the first communication passage **223** in the storage space **220**. Toner is conveyed through the circulation passage counterclockwise in FIG. **4**.

The toner supply port **25** (developer receiving port) is an opening formed in the top portion, and is disposed above and near a left end of the first conveyance passage **221**. The toner supply port **25** faces the above-mentioned circulation passage, and functions to allow replenishment toner (replenishment developer) supplied from the toner container **30** to flow into the storage space **220**.

The first stirring screw **23** is disposed in the first conveyance passage **221**. The first stirring screw **23** includes a first rotary shaft **23***a*, and a first spiral blade **23***b* (screw blade) in the form of a spiral protrusion formed on the circumferential surface of the first rotary shaft **23***a*. The first stirring screw **23** is driven to rotate around the axis of the first rotary shaft **23***a* (in the direction of an arrow R**2**) to convey toner in the direction of an arrow D**1** shown in FIG. **4**. The first stirring screw **23** conveys toner so that the toner passes through a portion of the first conveyance passage **221** that faces the toner supply port **25**. Thus, the first stirring screw **23** functions to convey and mix toner having been conveyed from the second conveyance passage **222** with new toner flowing in from the toner supply port **25** in the first conveyance passage **221**. A first paddle **23***c* is disposed in a downstream part of the first stirring screw **23** in the toner conveying direction (in the arrow D**1** direction). The first paddle **23***c* is configured by a plate-like member disposed on the first rotary shaft **23***a*. The first paddle **23***c* is rotated with the first rotary shaft **23***a* to deliver toner from the first conveyance passage **221** to the second conveyance passage **222** in the direction of an arrow D**4** shown in FIG. **4**.

The second stirring screw **24** is disposed in the second conveyance passage **222**. The second stirring screw **24** includes a second rotary shaft **24***a*, and a second spiral blade **24***b* in the form of a spiral protrusion formed on the circumferential surface of the second rotary shaft **24***a*. The second stirring screw **24** is driven to rotate around the axis of the second rotary shaft **24***a* (in the direction of an arrow R**1**) to supply toner to the developing roller **21** while conveying toner in the direction of an arrow D**2** shown in FIG. **4**. A second paddle **24***c* is disposed in a downstream part of the second stirring screw **24** in the toner conveying direction (in the arrow D**2** direction). The second paddle **24***c* is rotated with the second rotary shaft **24***a* to deliver toner from the second conveyance passage **222** to the first conveyance passage **221** in the direction of an arrow D**3** shown in FIG. **4**.

The toner container **30** (FIG. **3**) is disposed above the toner supply port **25** of the development housing **210**. The toner container **30** includes a toner discharge port **319** (FIG. **4**). The toner discharge port **319** is disposed at a bottom portion **311** (FIG. **6**) of the toner container **30** and corresponds to the toner supply port **25** of the development housing **20**. Toner falling through the toner discharge port **319** passes through the toner supply port **25** to be supplied to the development device **20**.

<Supply of Toner>

Now, there will be described a flow of toner that is newly supplied through the toner supply port **25**. FIG. **5** is a sectional view showing the vicinity of the toner supply port **25** disposed in the developing device **20** and the toner discharge port **319** disposed in the toner container **30**.

Replenishment toner T**2** being supplied through the toner discharge port **319** of the toner container **30** falls into the first conveyance passage **221** to be mixed with existing toner T**1**, and the mixture of toners T**1** and T**2** are conveyed in the arrow D**1** direction by the first stirring screw **23**. At this time, the toners T**1** and T**2** are stirred and charged.

The first stirring screw **23** includes a reducing paddle **28** (conveying ability reducing portion) disposed downstream of the toner supply port **25** in the toner conveying direction, the

reducing paddle for partially reducing the ability of conveying toner. In the present embodiment, the reducing paddle **28** is configured by a plate-like member extending between a particular advancing point and a particular receding point of a turn of the first spiral blade **23***b* of the first stirring screw **23**. The reducing paddle **28** rotates with the first rotary shaft **23***a* to cause toner being conveyed from the upstream side of the reducing paddle **28** to begin to accumulate. The accumulation of toner grows up to immediately upstream of the reducing paddle **28**, that is, a portion where the toner supply port **25** faces the first conveyance passage **221**. As a result, a tonner accumulation portion **29** (developer accumulation portion) appears near the inlet of the toner supply port **25**.

When the amount of toner in the storage space **220** increases as a result of the supply of replenishment toner T2 though the toner supply port **25**, the toner of the accumulation portion **29** covers (seals) the toner supply port **25**, which prevents further toner supply. Thereafter, as the toner of the accumulation portion **29** decreases due to consumption of toner in the storage space **220** by the developing roller **21**, the amount of toner covering the toner supply port **25** decreases such that a gap appears between the accumulation portion **29** and the toner supply port **25**. This allows new inflow of replenishment toner T2 into the storage space **220** through the toner supply port **25**. As described, the present embodiment employs the volume replenishment type toner supply method in which the amount of replenishment toner to be received is adjusted according to the decrease in the amount of toner of the accumulation portion **29**.

<Structure of Toner Container>

Now there will be described a toner container **30** (developer container) according to a first embodiment of the present invention with reference to FIGS. **6** to **11**. FIGS. **6** and **7** are perspective views of the toner container **30** according to the present embodiment. FIG. **8**A is a plan view of the toner container **30**, FIG. **8**B is a front view of the toner container **30**, and FIG. **8**C is a side view of the toner container **30**. FIG. **9** is an exploded perspective view of the toner container **30**. FIGS. **10**A and **10**B are perspective views of a movable wall **34** of the toner container **30**. FIG. **11** is a sectional view of the toner container **30**.

The toner container **30** is substantially in the form of a cylinder. The toner container **30** contains replenishment toner (developer). With reference to FIGS. **9** and **11**, the toner container **30** includes a container body **31** (container body), a stirring disc **32**, a shaft **33** (shaft), the movable wall **34**, a washer **35** (FIG. **9**), a sponge seal **36**, a lid **37**, a rotary gear **38** (drive transmitter), a cover **39**, and screws **40** (FIG. **9**).

The container body **31** constitutes the body of the toner container **30** and is substantially in the form of a cylinder. The container body **31** includes an inner circumferential portion **31**K (inner surface) and an internal space **31**H (FIGS. **9** and **11**). The inner circumferential portion **31**K is defined by the inner surface of the container body **31**. The internal space **31**H is in the form of a cylinder extending in a longitudinal direction (in a first direction, the direction of an arrow DA shown in FIGS. **6**, **7**, and **11**) and is defined by the inner circumferential portion **31**K.

The container body **31** includes a bottom portion **311**, a top portion **312**, a front wall **313** (side wall), a rear wall **314** (side wall), a left wall **315** (wall portion), and a flange **316**. The bottom portion **311** constitutes the bottom of the container body **31** and is in the form of a half cylinder projecting downward. In other words, the bottom portion **311** has an arc shape in sectional view perpendicularly intersecting the first direction. The front wall **313** and the rear wall **314** are a pair of side walls standing upward on the opposite lateral ends of the bottom portion **311**. The top portion **312** is disposed above the bottom portion **311** to cover the internal space **31**H from above. The left wall **315** joins one end (left end) of each of the bottom portion **311**, the front wall **313**, the rear wall **314**, and the top portion **312** in the first direction, thereby covering the container body **31**. The internal space **31**H is defined by the bottom portion **311**, the top portion **312**, the front wall **313**, the rear wall **314**, and the left wall **315**, and also by the lid **37** described later. The internal space **31**H includes a storage space **31**S defined between the left wall **315** and the movable wall **34** described later. The storage space **31**S is a space where toner is contained in the toner container **30**.

As shown in FIG. **9**, the container body **31** is open at an end thereof that is opposite to the left wall **315** in the first direction. The flange **316** defines this opening and has an outer diameter greater than that of the opposite end of the container body **31** in the first direction. The flange **316** is attached with the lid **37** described later.

The container body **31** includes a shutter **317**, a first guiding portion **318**, and a toner discharge port **319** (developer discharge port). The shutter **317** is disposed at one end of the container body **31** in the first direction. The shutter **317** can be slid in the first direction. The shutter **317** closes (seals) the toner discharge port **319** from the outside of the container body **31**, and exposes the toner discharge port **319** to the outside.

The first guiding portion **318** is in the form of a protrusion vertically extending on the outer surface of the left wall **315**. The first guiding portion **318** guides mounting of the toner container **30** into the housing **101** in cooperation with a second guiding portion **392** described later.

The toner discharge port **319** is an opening formed in a lower part of the inner circumferential portion **31**K of the container body **31** and communicates with the internal space **31**H (storage space **31**S). As shown in FIGS. **8**B and **9**, the toner discharge port **319** is formed at the one end of the container body **31** in the first direction. Further, the toner discharge port **319** is formed along the arc shape of the bottom portion **311** and having a predetermined width in the first direction. Toner contained in the storage space **31**S is discharged through the toner discharge port **319** toward the developing device **20**. In the present embodiment, as described above, the internal space **31**H of the container body **31** is defined by the bottom portion **311**, the front wall **313**, the rear wall **314**, and the top portion **312**. Therefore, the toner in the storage space **31**S concentrates at a mid-portion of the arc-shaped bottom portion **311** by its own weight. This allows the toner, which is conveyed by the movable wall **34** described later, to be efficiently discharged through the toner discharge port **319**.

The stirring disc **32** (FIGS. **9** and **11**) is configured by a plate member in the form of a disc. The stirring disc **32** is secured to a second shaft end portion **332** of the shaft **33** described later, and rotates integrally with the shaft **33**. The stirring disc **32** is disposed along the left wall **315** in the storage space **31**S of the container body **31**. The stirring disc **32** functions to stir toner existing over the toner discharge port **319**.

The shaft **33** is disposed in the internal space **31**H and extends in the first direction, the shaft **33** being rotatably supported on the container body **31** and the lid **37** described later. The shaft **33** includes a first shaft end portion **331**, the second shaft end portion **332**, a male thread **333** (first engaging portion), and a movable wall stopper portion **334**.

The first shaft end portion **331** (FIG. **11**) is defined by one end of the shaft **33** in the first direction. The first shaft end portion **331** is axially supported in a lid shaft hole **37**J of the

lid **37** described later. The second shaft end portion **332** is defined by the other end of the shaft **33** in the first direction. The second shaft end portion **332** is axially supported in a main body bearing **31**J (FIG. **11**) formed in the left wall **315** of the container body **31**. The male thread **333** is in the form of a helical ridge projecting from the outer surface of the shaft **33** in the internal space **31**H. In the present embodiment, the male thread **333** extends on the shaft **33** from a position facing the flange **316** to a position immediately preceding the toner discharge port **319**, as shown in FIG. **11**. The movable wall stopper portion **334** is disposed downstream of the male thread **333** in the first direction. The movable wall stopper portion **334** is defined by a specific part of the shaft **33**, the specific part not bearing the male thread **333**. The movable wall stopper portion **334** is disposed above the toner discharge port **319**.

The movable wall **34** is disposed in the container body **31** and in the form of a wall extending in a direction perpendicularly intersecting the first direction. The movable wall **34** defines one end surface (right end surface) of the storage space **31**S in the first direction. The other end surface (left end surface) of the storage space **31**S in the first direction is defined by the left wall **315** and the stirring disc **32**. The movable wall **34** is moved to the toner discharge port **319** in the first direction from a right end side toward a left end side of the internal space **31**H while conveying toner contained in the storage space **31**S to the toner discharge port **319**, during a time period from the beginning of use to the end of use of the toner container **30**. The movable wall **34** can be moved only in the left direction by a motor M described later.

With reference to FIGS. **10**A and **10**B, the movable wall **34** includes a conveying wall portion **340**, an outer peripheral wall portion **341**, an inner wall seal **342** (sealing member), a shaft seal **343** (cleaning member), supply opening caps **344** (closing member), a movable wall shaft hole **34**J, and an outer circumferential portion **34**K (outer surface).

The conveying wall portion **340** defines the storage space **31**S in cooperation with the inner circumferential portion **31**K of the container body **31**. In particular, the conveying wall portion **340** includes a conveying surface **340**S extending in a direction perpendicular to the shaft **33**. The conveying surface **340**S conveys toner in the storage space **31**S by pressing it in the movement of the movable wall **34**. The conveying wall portion **340** further includes a bearing **340**A, toner supply openings **340**B (developer filling port), and a cylinder part **340**C. The bearing **340**A is formed in a substantially central part of the conveying wall portion **340**. The bearing **340**A moves in the first direction while holding the movable wall **34**. The above-described shaft **33** is inserted in the bearing **340**A. The toner supply openings **340**B are formed above the bearing **340**A and pass through the conveying wall portion **340** in the first direction. Upon attachment of the movable wall **34** to the container body **31**, the toner supply openings **340**B communicate with the storage space **31**S. Replenishment toner is filled into the storage space **31**S through the toner supply openings **340**B when the toner container **30** is manufactured.

The cylinder part **340**C projects from the surface of the conveying wall portion **340** that is opposite to the conveying surface **340**S in the first direction. The cylinder part **340**C constitutes a part of the bearing **340**A. The cylinder part **340**C includes a female thread **340**D (second engaging portion). The female thread **340**D is in the form of a helical ridge projecting from the inner surface of the cylinder part **340**C. The female thread **340**D functions to move the movable wall **34** in the first direction by engaging with the male thread **333** of the shaft **33**. At this time, an inner wall of the cylinder part **340**C comes into contact with an outer circumferential portion of the shaft **33**, whereby the position of the movable wall **34** is maintained. Therefore, the conveying wall portion **340** of the movable wall **34** is prevented from tilting with respect to the shaft **33**.

The outer peripheral wall portion **341** projects from an outer peripheral edge of the conveying wall portion **340** in a direction away from the storage space **31**S, namely, in the direction opposite to the moving direction of the movable wall **34**. The outer peripheral wall portion **341** faces the inner circumferential portion **31**K of the container body **31**. The outer peripheral wall portion **341** includes ribs **341**A and a discharge port sealing part **341**B. The ribs **341**A are disposed on the outer peripheral wall portion **341** and extend in the first direction. The ribs **341**A are spaced from one another in a circumferential direction of the outer peripheral wall portion **341**. The ribs **341**A are in slight contact with the inner circumferential portion **31**K, and function to prevent the movable wall **34** from tilting in the first direction in the container body **31**. The discharge port sealing part **341**B is defined by a lowest part of the outer peripheral wall portion **341** and has a sufficient size to cover the toner discharge port **319**.

The inner wall seal **342** is disposed on the outer peripheral wall portion **341** on a rear end joining the conveying wall portion **340** in such a way as to ride on a circumference of the rear end of the outer peripheral wall portion **341**. As shown in FIG. **10**A, the inner wall seal **342** is first secured to the top of the conveying wall portion **340** at a first seal end **342**A thereof, and is then wound around the conveying wall portion **340** and finally secured at a second seal end **342**B thereof in such a manner that the first seal end **342**A and the second seal end **342**B overlap each other. The inner wall seal **342** is resiliently compressed between the inner circumferential portion **31**K of the container body **31** and the movable wall **34**. The inner wall seal **342** defines the outer circumferential portion **34**K of the movable wall **34**. The outer circumferential portion **34**K is slidably disposed in close contact with the inner circumferential portion **31**K of the container body **31**. The inner wall seal **342** prevents toner in the storage space **31**S from flowing out to the upstream side of the movable wall **34** in the moving direction through the gap between the inner circumferential portion **31**K of the container body **31** and the movable wall **34**.

The shaft seal **343** is disposed on the bearing **340**A at the downstream side of the female thread **340**D in the moving direction of the movable wall **34** (FIG. **11**). The shaft seal **343** comes in contact with the male thread **333** of the shaft **33** in the movement of the movable wall **34**. At this time, the shaft seal **343** comes in contact with the male thread **333** before the female thread **340**D to clean toner adhered on the male thread **333**. This allows the male thread **333** to engage with the female thread **340**D after toner adhered thereon is removed almost completely. Therefore, it is possible to prevent aggregation of toner between the male thread **333** and the female thread **340**D and consequently allow a stabilized movement of the movable wall **34**. Further, the shaft seal **343** is in the form of a ring, and therefore is in close contact with the shaft **33** over the entire circumference of the shaft **33** for sealing the bearing **340**A. This prevents toner in the storage space **31**S from flowing out to the upstream side of the movable wall **34** in the moving direction through the bearing **340**A. The movable wall shaft hole **34**J allowing the shaft **33** to pass therethrough is defined radially inside the shaft seal **343** being in the form of a ring and the cylinder part **340**C.

The supply opening caps **344** are fitted in the toner supply openings **340**B through the inside of the outer peripheral wall portion **341** to seal the toner supply openings **340**B, as shown

in FIG. **10**B. After replenishment toner is filled in the container space **31**S through the toner supply openings **340**B, the supply opening caps **344** are respectively fitted into the toner supply openings **340**B. Consequently, the toner is prevented from leaking through the toner supply openings **340**B.

The washer **35** (FIG. **9**) is disposed between the cylinder part **340**C of the movable wall **34** and the sponge seal **36** and placed around the shaft **33**.

The sponge seal **36** is disposed between the washer **35** and the lid **37**. The sponge seal **36** prevents leakage of toner through the lid shaft hole **37**J of the lid **37** described later, the lid **37** being secured to the container body **31**.

The lid **37** (FIGS. **9** and **11**) is secured to the flange **316** of the container body **31** and seals the opening of the container body **31**. The lid **37** includes the lid shaft hole **37**J. The shaft **33** is rotatably and axially supported in the lid shaft hole **37**J at the first shaft end portion **331**.

The rotary gear **38** is secured to the first shaft end portion **331** of the shaft **33**. A distal end of the first shaft end portion **331** has a D-shape in sectional view perpendicularly intersecting its axial direction. The rotary gear **38** is formed with an unillustrated D hole in a central part thereof, the D hole engaging with the distal end of the first shaft end portion **331** having the D-shape. The rotary gear **38** rotates integrally with the shaft **33**. The rotary gear **38** includes an outer peripheral gear portion **381**. The outer peripheral gear portion **381** is defined by an outer peripheral portion of the rotary gear **38**. The gear teeth of the outer peripheral gear portion **381** are not shown in the drawings. The rotary gear **38** is connected to the motor M (FIG. **8**B) (driving source) disposed in the housing **101** of the printer **100**. Upon receipt of a torque from the motor M, the rotary gear **38** transmits the torque to the shaft **33** to move the movable wall **34** in the first direction.

The cover **39** is disposed at an end of the toner container **30**. With reference to FIG. **8**C, the cover **39** has such a shape to cover a half of the circular side face of the rotary gear **38**. In other words, when the cover **39** is secured to the container body **31** via the lid **37**, a half of the circular side face of the rotary gear **38** is exposed to the outside of the toner container **30**. The cover **39** includes a shaft cover portion **391** and the second guiding portion **392**. The shaft cover portion **391** is formed in a central part of the cover **39** and is in the form of a cylinder. The shaft cover portion **391** covers the end of the first shaft end portion **331** projecting from the rotary gear **38**. The second guiding portion **392** is disposed behind the shaft cover portion **391** and is in the form of a protrusion vertically extending. The second guiding portion **392** functions to guide mounting of the toner container **30** into the printer **100**.

Each of the screws **40** is fastened to the flange **316** of the container body **31** after being inserted into unillustrated screw holes respectively formed in the lid **37** and the cover **39**. Consequently, the container body **31**, the lid **37**, the rotary gear **38**, and the cover **39** constitute an integral structure, with the stirring disc **32**, the shaft **33**, and the movable wall **34** being disposed in the internal space **31**H.

Further, the toner container **30** includes a toner sensor **31**T (FIGS. **8**A and **8**B). The toner sensor **31**T is disposed on the top portion **312** of the container body **31** above the toner discharge port **319**. The toner sensor **31**T includes a magnetic permeability sensor or a piezoelectric element. In the case where the toner sensor **31**T includes a piezoelectric element, a sensing portion of the toner sensor **31**T is exposed to the storage space **31**S. The toner sensor **31**T outputs a HIGH signal (+5V) in response to being pressed by toner in the storage space **31**S. Further, when no toner exists directly under the toner sensor **31**T, the toner sensor **31**T outputs a LOW signal (0V). A signal outputted by the toner sensor **31**T is referred to by a controller **50** described later. In the case where the toner sensor **31**T is configured as a magnetic permeability sensor, the sensor does not need to make direct contact with toner. Therefore, in other embodiments, the toner sensor **31**T may be disposed on the housing **101** of the printer **100** and opposite an outer wall of the container body **31**. Further, the toner sensor **31**T is not limited to be disposed on the top portion **312**. In other embodiments, the toner sensor may be disposed on any one of the bottom portion **311**, the front wall **313**, and the rear wall **314** of the container body **31**. In the case where the toner sensor is disposed on a lowest part of the bottom portion **311**, the toner discharge port **319** may be formed at a position circumferentially away from the lowest part.

<Function of Toner Container>

As described above, the toner container **30** can be attached to and detached from the developing device **20**. With reference to FIG. **2**, when the opening/closing cover **100**C of the housing **101** is opened upward, a container housing space **109** is exposed to the outside of the housing **101**, the container housing space **109** constituting a part of the main body internal space **107**. In the present embodiment, the toner container **30** is mounted in the container housing space **109** from above (see an arrow DC shown in FIGS. **6** and **7**). At this time, the cover **39** of the toner container **30** comes to rest at the right end of the container housing space **109**, and the left wall **315** of the toner container **30** comes to rest at the left end of the container housing space **109**. The printer **100** includes guide grooves **109**A (FIG. **2**). The guide grooves **109**A are formed in the container housing space **109** and vertically extend. Although FIG. **2** shows only a right guide groove **109**A, there is also a left guide groove **109**A similarly disposed at the left end of the container housing space **109**.

The toner container **30** is mounted in the container housing space **109** by a user, with the first guiding portion **318** and the second guiding portion **392** engaging with the pair of guide grooves **109**A. After the toner container **30** is mounted in the container housing space **109**, a user or an unillustrated opening/closing mechanism slides the shutter **317** to open the toner discharge port **319**. Consequently, the toner discharge port **319** lies above and opposite the toner supply port **25** (FIGS. **4** and **5**).

FIGS. **12**A, **12**B, and **12**C are sectional views each illustrating a movement state of the movable wall **34** in the toner container **30**. FIG. **12**A shows the movable wall **34** located at an initial position. FIG. **12**B shows the movable wall **34** having moved from the initial position in the first direction. FIG. **12**C shows the movable wall **34** located at a final position.

As shown in FIG. **12**A, when the toner container **30** is newly mounted in the printer **100** by a user, the movable wall **34** lies at the initial position adjacent to the lid **37** and remote from the toner discharge port **319** at one end side of the internal space **31**H in the first direction. Even if the storage space **31**S is maximally filled with toner when the toner container **30** is manufactured, a slight space is left in the storage space **31**S. This space is necessary to impart a predetermined fluidity to the toner contained in the storage space **31**S before use of the toner container **30**. However, in this case, because a boundary surface (top surface) of the toner contained in the storage space **31**S is located under the top portion **312** with a specific gap therebetween, the toner sensor **31**T can be seen to be difficult to detect the toner contained in the storage space **31**S with high accuracy.

Accordingly, when the toner container **30** is newly mounted in the printer **100**, the controller **50** (FIG. **8**B) causes the motor M to drive the rotary gear **38** and the shaft **33** for

rotation. This brings the male thread **333** into engagement with the female thread **340**D to thereby impart a moving force to the movable wall **34** in the first direction toward the toner discharge port **319**. When the movable wall **34** has moved slightly leftward from the initial position shown in FIG. **12**A, the storage space **31**S is filled up with toner. This allows the toner sensor **31**T to detect the toner in the storage space **315**. Upon receipt of the HIGH signal outputted from the toner sensor **31**T, the controller **50** causes the movement of the movable wall **34** to stop.

In the present embodiment, the inner circumferential portion **31**K of the container body **31** and the outer circumferential portion **34**K (outer peripheral wall portion **341**) of the movable wall **34** each have, in sectional view perpendicularly intersecting the first direction, a non-circular shape. This makes it possible to prevent the movable wall **34** from rotating with respect to the container body **31** even when the movable wall **34** receives a force for rotation around the shaft **33**, owing to the engagement of the male thread **333** and the female thread **340**D. Consequently, the movable wall **34** can be moved steadily in the first direction by a torque of the motor M. Further, the engagement of the male thread **333** and the female thread **340**D allows the movable wall **34** to move steadily in the first direction with the outer circumferential portion **34**K of the movable wall **34** being in close contact with the inner circumferential portion **31**K of the container body **31** as described above.

As described above, the present embodiment employs the volume replenishment type toner supply method as shown in FIG. **5**. Therefore, when the toner supply port **25** is sealed by the accumulation portion **29** (FIG. **5**) existing in the developing device **20** from below, no replenishment toner falls from the toner container **30**. On the other hand, when the toner of the accumulation portion **29** decreases as a result of supply of toner from the developing roller **21** of the developing device **20** to the photoconductive drum **121**, toner flows into the developing device **20** through the toner supply port **25** from the toner discharge port **319**. Consequently, toner that has existed under the toner sensor **31**T disappears in the storage space **31**S of the toner container **30**, which causes the toner sensor **31**T to output the LOW signal. Upon receipt of the signal, the controller **50** drives the motor M to move the movable wall **34** toward the toner discharge port **319** (FIG. **12**B) until the toner sensor **31**T outputs the HIGH signal. At this time, the stirring disc **32** disposed at the extreme end of the storage space **31**S rotates with the shaft **33** to stir toner existing above the toner discharge port **319**. This increases the fluidity of the toner, so that toner falls through the toner discharge port **319** constantly.

The movable wall **34** reaches the final position near the toner discharge port **319** as a result of progressive consumption of toner from the storage space **31**S of the toner container **30**, as shown in FIG. **12**C. In this manner, the movable wall **34** gradually moves in the first direction to thereby convey toner in the storage space **31**S to the toner discharge port **319** by pushing it. At this time, the storage space **31**S gradually decreases as the movable wall **34** approaches the toner discharge port **319**. Therefore, the space accommodating remaining toner gradually disappears in the toner container **30**. Finally, at the final position shown in FIG. **12**C, the movable wall **34** comes into contact with the stirring disc **32**, so that the storage space **31**S almost disappears. This makes it possible to reduce the amount of toner remaining in the storage space **31**S of the container body **31** at the end of use of the toner container **30**, as compared to the conventional toner container whose storage space volume does not change.

When the movable wall **34** reaches the final position facing the toner discharge port **319**, the discharge port sealing part **341**B (FIG. **10**B) of the movable wall **34** covers the toner discharge port **319** from the inside of the container body **31** (FIG. **12**C). In other words, the movable wall **34** has a shutter function of covering the toner discharge port **319** when the toner in the container body **31** runs out. This makes it possible to, even when the toner container **30** is dismounted from the printer **100** with the shutter **317** left open, prevent a small amount of toner remaining in the gap between the stirring disc **32** and the movable wall **34** from leaking or scattering out of the toner discharge port **319**. In particular, in the present embodiment, the inner wall seal **342** being in close contact with the inner circumferential portion **31**K of the container body **31** lies at the downstream end of the movable wall **34** in the moving direction during the movement of the movable wall **34**. Consequently, the discharge port sealing part **341**B covering the toner discharge port **319** is hardly adhered with toner, the discharge port sealing part **341**B lying at the upstream side of the inner wall seal **342** in the moving direction of the movable wall **34**. In addition, the width of the outer peripheral wall portion **341** is set to be longer than the width of the toner discharge port **319** in the first direction, so that the discharge port sealing part **341**B has a size sufficient to cover the toner discharge port **319**. Therefore, it is possible to reliably cover the toner discharge port **319** by the discharge port sealing part **341**B.

Further, when the movable wall **34** seals the toner discharge port **319** at the final position as described above, a user can recognize that the toner has run out by seeing the sealing state. When the amount of toner remaining in the toner container **30** decreases, it is difficult to tell the amount of remaining toner by the weight of the toner container **30**. On the other hand, in the case where the shutter **317** is slid as described above, a user can reliably recognize, by seeing that the toner discharge port **319** is sealed by the movable wall **34**, that the toner in the toner container **30** has run out. Consequently, the user can be prompted to replace the toner container **30**.

Further, the above-described function of the movable wall **34** of sealing the toner discharge port **319** can be utilized also in the case where a toner container **30** that has been partially used is dismounted from the printer **100** for some reason and stored with other empty toner containers **30**. Specifically, a user is only required to choose a toner container **30** in which the toner discharge port **319** is not sealed by the movable wall **34**, from among the plurality of stored toner containers **30**.

In addition, in the case where the volume replenishment type toner supply method is employed as described above, when the toner in the toner container **30** runs out, no replenishment toner presses the accumulation portion **29**, so that no pressing force is exerted to the developing device **20** from the toner container **30**. In this case, there is a possibility that a part of the toner in the developing device **20** flows back toward the toner discharge port **319** through the toner supply port **25** because of various conditions in the developing device **20**. However, in the present embodiment, the movable wall **34** seals the toner discharge port **319**. This can prevent the toner from flowing back into the container body **31** from the developing device **20** (supply receiver).

In addition, in the present embodiment, the toner supply openings **340**B for filling toner into the storage space S are formed in the movable wall **34** when the toner container **30** is manufactured, as described above. Therefore, there is no need to form a filling port in the container body **31** in addition to the toner discharge port **319**. Therefore, the container body **31** can be formed in a simple shape. There may be provided toner containers **30** filled with different amounts of toner by vary-

ing the initial position of the movable wall **34** in the first direction. It is possible to change the volume of the storage space **31**S by changing the initial position of the movable wall **34** at the time of filling toner. Also in this case, the toner supply openings **340**B are formed in the movable wall **34** of each of the toner containers **31** and, therefore, it is not necessary to form a filling port in the container body **31** of each of the toner containers **30** at different positions from one another according to the amount of toner to be filled. This allows use of the container bodies **31** of the same type. Further, even in the case where toner containers **30** are filled with different amounts of toner, the initial position of the movable wall **34** of each of the toner containers **30** may be commonly set at a position shown in FIG. **12**A. In this case, when a toner container **30** is mounted in the printer **100**, a driving time for allowing the motor M to run is adjusted according to the output signal of the toner sensor **31**T as an initial setting. Consequently, the storage space **31**S is filled up with toner.

Further, the toner container **30** includes a backward movement preventing mechanism **55** (FIG. **11**). The backward movement preventing mechanism **55** prevents the movable wall **34** having reached the toner discharge port **319** from moving back toward the initial position. In the present embodiment, the movable wall stopper portion **334** of the shaft **33** functions as the backward movement preventing mechanism **55** as shown in FIGS. **11** and **12**A. The movable wall stopper portion **334** is defined by a specific part of the shaft **33**, the specific part not bearing the male thread **333** and facing the toner discharge port **319**, as described above. Therefore, the female thread **340**D (FIG. **10**B) of the movable wall **34** disengages from the male thread **333** and comes to lie in front of the movable wall stopper portion **334**, immediately before the movable wall **34** reaches the final position shown in FIG. **12**C. Thus, once the movable wall **34** reaches the final position shown in FIG. **12**C, the female thread **340**D is prevented from engaging with the male thread **333** again. Consequently, the movable wall **34** will never move back toward the lid **37** even if the rotary gear **38** is rotated accidentally inversely. Therefore, as described above, it is possible to reliably locate the movable wall **34** at the final position when the toner container **30** is empty of the toner. This can prevent leakage or scattering of toner out of the toner discharge port **319**. Further, even in the case where a used toner container **30** is stored in a vertical position such that the first direction agrees with a vertical direction, the movable wall **34** is prevented from moving back toward the lid **37** by its own weight.

Further, at the final position shown in FIG. **12**C, the inner wall seal **342** of the movable wall **34** resiliently radially biases the inner circumferential portion **31**K of the toner container **30** from the inside. This allows the movable wall **34** to be stably locked at the final position and thereby further prevented from moving backward.

Now, a toner container **30**Q according to a second embodiment of the present invention will be described with reference to FIGS. **13**A, **13**B and **14**. FIGS. **13**A and **13**B are perspective views of a movable wall **34**Q of the toner container **30**Q. FIG. **14** is a sectional perspective view of the toner container **30**Q with a shutter **317**Q closed. In these drawings, elements that have functions identical to those of the corresponding elements of the toner container **30** in the first embodiment are denoted by the same reference numerals as in the first embodiment, with "Q" added at the end. The second embodiment differs from the toner container **30** of the first embodiment in the structures of the shutter **317**Q and the movable wall **34**Q. Accordingly, description will be made mainly regarding the difference, and repeated description of other common features will be omitted.

The toner container **30**Q includes a container body **31**Q, the shutter **317**Q, and the movable wall **34**Q. With reference to FIG. **14**, the shutter **317**Q is in the form of a cylinder and fitted on the outer surface of the container body **31**Q. The shutter **317**Q functions to close and open a toner discharge port **319**Q) of the container body **31**Q. The shutter **317**Q includes a shutter holder **317**Q**1**. The shutter holder **317**Q**1** projects upward from the shutter **317**Q. The shutter holder **317**Q**1** is held by a user after the toner container **30**Q is mounted in the container storage **109** (FIG. **2**) of the printer **100**. The user slides the shutter holder **317**Q**1** in a left-right direction to thereby move the shutter **317**Q to a position at which the toner discharge port **319**Q is covered by the bottom end of the shutter **317**Q or to a position at which the toner discharge port **319**Q is open.

With reference to FIGS. **13**A and **13**B, the movable wall **34**Q has substantially the same structure and shape as those of the movable wall **34** of the first embodiment. However, as shown in FIG. **13**A, an inner wall seal **342**Q of the movable wall **34**Q is formed to be wide in the left-right direction (first direction). The lateral width of the inner wall seal **342**Q is set to be longer than the lateral opening width of the toner discharge port **319**Q shown in FIG. **14**.

Also in the second embodiment, when the movable wall **34**Q reaches a final position, the inner wall seal **342**Q covers the entirety of the toner discharge port **319**Q from the inside of the container body **31**Q, as shown in FIG. **14**. Therefore, it is possible to reliably seal the toner discharge port **319**Q by the movable wall **34**Q. Further, the inner wall seal **342**Q is made of a resilient material such as urethane. Therefore, the inner wall seal **342**Q is partially released from a resiliently compressed state at the toner discharge port **319**Q. Consequently, a part of the surface of the inner wall seal **342**Q protrudes out of the toner discharge port **319**Q radially outward of a shaft **33**Q. This allows a part of the inner wall seal **342**Q to be closely adhered to the peripheral edge of the toner discharge port **319**Q and thereby improve its ability of sealing the toner discharge port **319**Q.

Further, also in the second embodiment, the movable wall **34**Q is prevented from moving back from the final position toward an initial position, owing to a movable wall stopper portion **334**Q defined by a specific part of the shaft **33**, the specific part not bearing a male thread **333**Q and facing the toner discharge port **319**Q. At this time, the protruding surface portion of the inner wall seal **342**Q is caught on an opening end **319**Q**1** (FIG. **14**) of the toner discharge port **319**. Therefore, the movable wall **34**Q is further prevented from moving back toward the initial position. In other embodiments, the inner wall seal **342**Q may have such a shape as to allow a seal end **342**Q**1** (FIG. **13**B) of the inner wall seal **342**Q to be located at the left side (i.e. the downstream side in the moving direction of the movable wall **34**Q) of the opening end **319**Q**1** when the movable wall **34**Q is at the final position shown in FIG. **14**. In this case, the seal end **342**Q**1** slightly protruding out of the toner discharge port **319** is likely to be easily caught on the opening end **319**Q**1**, which will further prevent the movable wall **34**Q from moving back toward the initial position.

When the shutter **317**Q is slid by a user after the movable wall **34**Q reaches the final position shown in FIG. **14**, the toner discharge port **31**Q is doubly sealed by the movable wall **34**Q and the shutter **317**Q. In particular, in the second embodiment, the toner discharge port **319**Q is sealed from the inside and the outside of the container body **31**Q. This makes it possible to stably prevent the vicinity of the container body **31**Q from getting stained with toner.

Now, a toner container **30**P according to a third embodiment of the present invention will be described with reference to FIG. **15**. FIG. **15** is a sectional view illustrating a state that a movable wall **34**P of the toner container **30**P is at a final position. In FIG. **15**, elements that have functions identical to those of the corresponding elements of the toner container **30** in the first embodiment are denoted by the same reference numerals as in the first embodiment, with "P" added at the end. The third embodiment differs from the toner containers **30** and **30**Q of the first and the second embodiments in the aspect of including a one-way clutch **385**. Accordingly, description will be made mainly regarding the difference, and repeated description of other common features will be omitted.

In the third embodiment, the one-way clutch **385**, in addition to a movable wall stopper portion **334**P disposed at a leading end of a shaft **33**P, functions as the backward movement preventing mechanism **55**. The one-way clutch **385** is secured to an inner circumferential portion of a rotary gear **38**P and fitted on an outer circumferential portion of a first shaft end portion **331**P.

While the rotary gear **38**P coaxially connected to the shaft **33**P is rotated in a first rotational direction (in the direction of an arrow R**1** shown in FIG. **15**) by the motor M (FIG. **8**B), a male thread **333**P of the shaft **33**P rotates. This allows a bearing **340**AP having a female thread **340**DP to move integrally with the movable wall **34**P in a first direction (in the direction of an arrow DA shown in FIG. **15**). At this time, the one-way clutch **385** connecting the shaft **33**P and the rotary gear **38**P transmits a torque of the first rotational direction transmitted from the motor M to the rotary gear **38** to the first shaft end portion **331**P.

After the movable wall **34**P reaches a toner discharge port **319**P, the toner container **30**P is dismounted from the printer **100** by a user. At this time, even if the user accidentally touches the rotary gear **38**P and rotates the rotary gear **38**P in a second rotational direction (in the direction of an arrow R**2** shown in FIG. **15**) opposite to the first rotational direction, the shaft **33**P is prevented from rotating in the second rotational direction, owing to the one-way clutch **385**. Therefore, the movable wall **34**P is prevented from moving back toward an initial position closer to a lid **37**P. Consequently, it is possible to prevent scattering of toner out of the toner discharge port **319**P. Further, in the third embodiment, the movable wall **34**P is prevented from moving back toward the initial position also during the movement in the first direction. This prevents accidental expansion of the storage space in a container body **31**P.

Now, a toner container **30**R according to a fourth embodiment of the present invention will be described with reference to FIGS. **16** to **18**. FIG. **16** is a sectional view illustrating a state that a movable wall **34**R of the toner container **30**R is at an initial position. FIGS. **17** and **18** are sectional views illustrating a state that the movable wall **34**R of the toner container **30**R is at a final position. In FIGS. **16** to **18**, elements that have functions identical to those of the corresponding elements of the toner container **30** in the first embodiment are denoted by the same reference numerals as in the first embodiment, with "R" added at the end. The fourth embodiment differs from the toner containers **30** and **30**Q of the first and the second embodiments in that a shaft **33**R slides. Accordingly, description will be made mainly regarding the difference, and repeated description of other common features will be omitted. In the fourth embodiment, a motor M (FIG. **16**) disposed in the printer **100** is rotatable in forward and backward directions

Similarly to the above-described embodiments, the toner container **30**R includes a container body **31**R, a stirring disc **32**R, the shaft **33**R (shaft), the movable wall **34**R, a lid **37**R, a rotary gear **38**R (drive transmitter), and a cover **39**R. The rotary gear **38**R includes a gear shaft hole **38**JR (shaft hole) and is coaxially disposed with respect to the shaft **33**R.

A first shaft end portion **331**R of the shaft **33** has a D-shape in sectional view. On the other hand, the gear shaft hole **38**JR of the rotary gear **38**R is in the shape of D. The first shaft end portion **331**R passes through the gear shaft hole **38**JR. The shaft **33**R is integrally rotatable with the rotary gear **38**R when the rotary gear **38**R is rotated in a first rotational direction (in the direction of an arrow R**1** shown in FIG. **16**) by a controller **50**R. In the fourth embodiment, the first shaft end portion **331**R is slidable in a first direction with respect to the gear shaft hole **38**JR.

Further, as shown in FIG. **16**, a left wall **315**R of the container body **31**R includes a cavity **315**R**1**. The cavity **315**R**1** is formed in the left wall **315**R and axially faces a second shaft end portion **332**R of the shaft **33**R when the movable wall **34**R is at the initial position. Similarly to the first shaft end portion **331**R, the second shaft end portion **332**R also has a D-shape in sectional view. The second shaft end portion **332**R passes through a D hole formed in the stirring disc **32**R to allow the stirring disc **32**R to integrally rotate with the second shaft end portion **332**R.

During the movement of the movable wall **34**R to a toner discharge port **319**R from the initial position shown in FIG. **16**, the shaft **33**R is imparted with a moving force in the right direction, owing to engagement of a male thread **333**R with a female thread **340**DR. However, because a distal end of the first shaft end portion **331**R is in contact with a shaft cover portion **391**R of the cover **39**R, the shaft **33**R is prevented from sliding rightward.

Upon arrival of the movable wall **34**R at the toner discharge port **319**R (FIG. **17**), the controller **5**OR controls the motor M to cause the rotary gear **38**R to rotate in a second rotational direction (in the direction of an arrow R**2** shown in FIG. **17**) opposite to the first rotational direction. At this time, the shaft **33**R is imparted with a moving force in the left direction (in the first direction or the direction of an arrow DA shown in FIG. **17**), owing to the engagement of the male thread **333**R with the female thread **340**DR. Consequently, the shaft **33**R slides leftward and the first shaft end portion **331**R disengages from the gear shaft hole **38**JR of the rotary gear **38**R (FIG. **18**). At the same time, the second shaft end portion **332**R of the shaft **33**R enters the cavity **315**R**1**. Thus, the shaft **33**R is prevented from receiving a torque from the rotary gear **38**R. Therefore, the movable wall **34**R having reached the final position is reliably prevented from moving back. In addition, also in the fourth embodiment, an inner wall seal **342**R of the movable wall **34**R pushes an inner circumferential portion **31**KR of the container body **31**R from the inside when the movable wall **34**R is at the final position. Therefore, the movable wall **34**R is prevented from moving back toward the initial position during the rotation of the rotary gear **38**R in the second rotational direction. As described above, in the fourth embodiment, the shaft **33**R and the cavity **315**R**1** function as the backward movement preventing mechanism **55**.

The toner container **30** (**30**P, **30**Q, **30**R) and the printer **100** including the same according to the embodiments of the present invention have been described. According to the above-described configurations, it is possible to form an image on a sheet while efficiently using the toner in the toner container. Further, it is possible to reliably maintain the covered state of the toner discharge port after the end of use of the toner container. The present invention is not limited to the

above-described embodiments and, for example, the following modified embodiments may be adopted.

(1) In the above-described embodiment, the printer **100** is illustrated as a monochrome printer. However, the present invention is not limited to this configuration. In particular, in the case where the printer **100** is provided as a tandem color printer, after the opening/closing cover **100**C (FIG. **2**) of the printer **100** is opened, toner containers **30** respectively corresponding to a plurality of colors may be mounted in the housing **101** from above so as to be adjacent to one another.

(2) In the first embodiment, the toner container **30** is mounted in the printer **100** in the longitudinal direction of the developing device **20**. However, the present invention is not limited to this configuration. It may be configured such that the toner container **30** is mounted in a direction intersecting the longitudinal direction of the developing device **20**.

(3) In the second embodiment, the toner container **30**Q includes the shutter **317**Q. However, the present invention is not limited to this configuration. As described above, the movable wall **34**Q seals the toner discharge port **319**Q when it reaches the final position. Accordingly, a film seal may be disposed at the toner discharge port **319**Q, the film seal for sealing the toner discharge port **319**Q until the toner container **30**Q begins to be used. When the toner container **30**Q is newly mounted in the printer **100**, the film seal is peeled off by a user. Consequently, the toner discharge port **319**Q is opened to communicate with an unillustrated developing device. Eventually, when toner in the toner container **30**Q runs out, the inner wall seal **342**Q of the movable wall **34**Q covers the toner discharge port **319**Q, as described above.

(4) The first embodiment employs the volume replenishment type toner supply method. However, the present invention is not limited to this method. An unillustrated toner sensor may be disposed at the developing device **20** so that when the toner sensor detects a decrease of toner in the developing device **20**, the controller **50** drives the motor M to move the movable wall **34** in the first direction. This allows toner to fall through the toner discharge port **319** to flow into the developing device **20**.

(5) In the first embodiment, the bearing **340**A is disposed in the central part of the movable wall **34**. However, the present invention is not limited to this configuration. The bearing **340**A may be disposed in another area of the movable wall **34**. It may be configured such that the bearing **340**A is disposed in an upper part of the movable wall **34**, and the shaft **33** correspondingly extends in an upper part of the container body **31**. In this case, pressure of toner that is exerted on the shaft seal **343** (FIG. **10**A) will be low, so that the shaft seal **343** can maintain a higher level of sealing ability.

The invention claimed is:

1. A developer container comprising:

a container body having opposite first and second ends and including an inner surface defining a cylindrical internal space extending in a longitudinal direction, and a storage space provided in the internal space for containing developer, the container body includes a wall portion at the first end of the container body in the longitudinal direction and defining a first end surface of the internal space, a lid attached to the second end of the container body and closing the internal space, the container body being formed with a developer discharge port in a lower part of the inner surface in proximity to the first end surface of the internal space and communicating with the storage space for discharging developer therethrough;

a movable wall disposed in the internal space of the container body, and including an outer surface disposed slidably in close contact with the inner surface, and a conveying surface defining the storage space in cooperation with the inner surface of the container body, the movable wall being movable in the longitudinal direction from an initial position in proximity to the second end of the container body to the developer discharge port lying in proximity to the first end of the internal space to seal the developer discharge port by the outer surface, while conveying the developer in the storage space to the developer discharge port;

a shaft extending in the longitudinal direction in the internal space and rotatably supported on the wall portion and the lid, the shaft including a first engaging portion in the form of a helical ridge projecting from an outer surface thereof;

a drive transmitter configured to transmit a torque generated by a specific driving source to the shaft; and

a bearing disposed in the movable wall, and including a second engaging portion projecting from an inner surface thereof and engageable with the first engaging portion, the bearing allowing the shaft to pass therethrough

a backward movement preventing mechanism configured to prevent the movable wall at the developer discharge port from moving back toward the initial position, wherein

the drive transmitter includes a rotary gear coaxially connected to the shaft, the rotary gear being rotatable in a first rotational direction to thereby allow the first engaging portion of the shaft to engage with the second engaging portion of the bearing to move the movable wall in the longitudinal direction, and

the backward movement preventing mechanism includes a one-way clutch connecting the shaft and the rotary gear, and preventing the shaft from rotating in a second rotational direction opposite to the first rotational direction.

2. A developer container according to claim **1**, wherein

the backward movement preventing mechanism is defined by a specific part of the shaft that faces the developer discharge port and bears no first engaging portion.

3. A developer container according to claim **1**, further comprising

a sealing member defining the outer surface of the movable wall and resiliently compressed between the inner surface of the container body and the movable wall.

4. A developer container according to claim **1**, wherein

the inner surface of the container body and the outer surface of the movable wall each have, in a sectional view perpendicularly intersecting the longitudinal direction, a non-circular shape.

5. An image forming apparatus, comprising:

a developer container according to claim **1**;

an image carrier having a surface for allowing an electrostatic latent image to be formed thereon and operable to carry a developed image;

a developing device configured to receive the developer supplied from the developer container and to supply the developer to the image carrier; and

a transfer section configured to transfer the developed image from the image carrier onto a sheet.

* * * * *